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INTEGRATED MEDICAL AND BEHAVIORAL LABORATORY MEASUREMENT SYSTEM
PHASE B II FINAL REPORT
VOLUME III - SYSTEM CONCEPT AND DESIGN
APPENDIX F
PROGRAM AND MANAGEMENT PLANS (UPDATED)

CONTRACT NASW—1630

PREPARED FOR THE

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

BY THE

BIOASTRONAUTIC SECTION

SPACE SYSTEMS ORGANIZATION

GENERAL ELECTRIC

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VOLUME II

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SECTION 1

INTRODUCTION

In response to the requirements of both the Phase B Work Statement and in accordance with good management practices, a series of management plans for conduct of an abbreviated Phase C program has been prepared and is submitted in this volume. The plans submitted and their contents correspond to those required by the Work Statement, as interpreted by General Electric.

These plans are drawn up based on the concept of a relatively small, closely-knit management and technical team supported, as required, by functional specialists and carrying out the preliminary design and planning for a high-quality hardware program. Using this concept, many management and planning activities (which in the large Phase D hardware program must be carried out on formalized, even computerized, basis) will be accomplished through the close communications and intimate involvement which a team permits. Generically, all needed activities and controls are present; the degree of formality and stylized activity is minimized commensurate with proper output and documentation.

SECTION 2

PROGRAM PLAN

2.1 INTRODUCTION

2.1.1 PURPOSE AND SCOPE

This Program Plan is in direct response to the requirements of Article II, Statement of Work, Section H.1. This document provides preliminary definition of the planning and management methods to be used in the "Phase C - Design" effort. This Program Plan summarizes and interrelates all of the plans described in Sections H-2 through 8 as well as provides an overview of the total Phase C Program. It is, therefore, the top level or controlling plan for the program.

The Program Plan is to be a working document issued and revised as required throughout the life of the program to reflect planning based on current program status and changing program requirements. Revision is to be made only after formal coordination with affected organizations.

This document provides uniform guidance and direction to all organizational elements and people committed to the program. It ensures that all tasks and subtasks included in the Contract Statement of Work are being pursued; it establishes master schedules against which more detailed schedules can be effectively and consistently developed; provides in summary form the allocation of resources including money, manpower, equipment, and facilities; establishes the management structures for the program and assigns responsibility for work and the level and number of persons assigned to the Program; it also defines policies, procedures and methods governing all program activities. The integration of these various factors results in a common understanding of contract requirements and a concerted uniform approach to the management of the program.

2.1.2 OBJECTIVES OF THE PHASE C PROGRAM

The objective of the Phase C program is to design the IMBLM System to meet the requirements as defined in "System Requirements" in Section 3.2 in Volume III of this report. The Phase C final report will document the preliminary design and associated efforts of this phase and define and propose the Phase D activity. The Phase C IMBLMS end products will include:

a. Requirements Documentation Package

b. Preliminary CEI Specifications for all prime and support equipment (as defined by Phase C)

c. Procurement specifications and associated control drawings

d. Drawings for Modules, Subsystems, Systems, and support equipment

e. Preliminary test specifications and plans

f. Preliminary reliability predictions and analyses

g. Planning for Phase D

h. Preliminary Safety Hazards analysis

i. Definitive Work Statement, Technical Proposal and Cost Proposal for Phase D.

2.1.3 RATIONALE UNDERLYING PREPARATION OF FUNCTIONAL AND MANAGEMENT PLANS

The following points were taken into consideration in the formulation of the functional and management plans for the Phase C portion of the IMBLMS program.

a. Phase C is expected to be a design effort on the order of $1 Million, with no hardware delivery involved. Operating procedures developed for multimillion dollar programs will not be required for a program of this size.

b. This system is to be a part of a large program and will therefore require certain procedures and forms for reporting in order to provide smooth integration and information flow to support interface activities with the other portions of the program, especially the Spacecraft Contractor and the NASA Headquarters and Manned Spacecraft Center.

c. A design program of this size has relatively short lines of communication and can therefore depend on the program personnel to be more effective in communicating and following through in all tasks related to the program - specifically, the Program Manager and the Engineering Manager can expect to keep very close to the day-to-day activities of the program.

d. The support organizations and services of the Departments and/or Division will be used selectively and judiciously in order to maintain responsibility and control within the IMBLMS program.

2.1.4 COMPLIANCE AND GUIDANCE DOCUMENTS USED

2.1.4.1 Compliance

NASA - RFP 10-1243, IMBLMS, December 27, 1966 (Compliance modified by proposed abbreviated Phase C in lieu of Phase C as described)

NPC 500-1 Apollo Configuration Management Manual (in portions, otherwise guidance)

MIL-D-1000, 1 March 1965

MIL-STD-100, March 1965.

2.1.4.2 Guidance

NPC 500-6 Apollo Documentation Administration Instructions

NPC 250-1 Reliability Program Provisions for Space Systems Contractors, July 1963

NPC 200-2 Quality Program Provisions for Space Systems Contractors, April 1962

NPC 500-10 Apollo Test Requirements Document, August 1964

Saturn/Apollo Application Program Technical Summary - OMSF, September 1, 1966

SID 65-1536 and Design 378-B - Experimenter Design Guide

NASA Working Paper No. 10.065 Orbital Workshop, MSC, Experiment Requirements

AFSCM 375-5 System Engineering Management Procedures

MD-E-8020-008B Natural Environment and Physical Standards for Apollo Program.

2.2 SUMMARY

2.2.1 PLAN FOR DEFINITION OF IMBLMS

Using the Phase 13 study results as a baseline, General Electric will develop IMBLMS definition during Phase C (abbreviated). The general plan encompasses the following areas.

2.2.1.1 Technical

2.2.1.1.1 Requirements

Initially, the effort will be to update and refine Phase B measurement and measurement equipment requirements. Based on this and other inputs and constraints (ex: Spacecraft requirements, etc.) General Electric will prepare a System Design Requirements Document for guidance of all contributors. Subsequently, these requirements inputs will continue to be studied and will be updated judiciously to bring the best available requirements to bear on the preliminary design without nullifying earlier progress. Included is continuous examination of potential suppliers' contributions.

2.2.1.1.2 Preliminary Design

Based upon these updated and refined requirements, preliminary subsystem requirements and module identifications will be made, and continuously refined through Phase C. Experiment/Spacecraft/equipment/human interfaces affecting each subsystem and between subsystems will be delineated and delineated and documented, specifically allowing for flexibility and growth. Each subsystem preliminary design will be accomplished through use of the above inputs and include tradeoffs of requirements with flexibility, growth potential, development problems, reliability, and safety. In particular, the number of units into which the IMBLMS ultimately is to be assembled will be critically examined in a tradeoff between application flexibility and problems of use (reliability, complexity, etc.). Resulting will be preliminary subsystem specifications, component identifications and specifications and, based upon all the above, reflection of the preliminary design into preliminary CEI Specifications including flight equipment, ground equipment, computer software and required equipments from the government and from other contractors.

2.2.1.1.3 Analysis and Support

Accompanying and supporting the above efforts are analyses by supporting specialists: reliability, safety, various technologies, human factors, etc; and tradeoff analyses led by system and subsystem lead design personnel. Specialists in safety, reliability, human factors, manufacturing engineering, quality, and many other areas will support this effort.

2.2.1.2 Management

The IMBLMS Phase C effort will be accomplished under the leadership of a close-knit team of selected personnel. Dr. Richard Lawton, M.D. is in overall charge. Mr. A.A. Little, Program Manager, is Deputy to Dr. Lawton for conduct of the program including definition, funding and control of all work and leadership of the Phase D planning. Mr. Gordon Fogal is responsible for all Engineering; Dr. Murray Smyth, M.D. for medical requirements and contributions, and Dr. Ted Marton, Ph.D. for behavioral requirements and human factors. Support from other functions in the Space Systems Organization is provided through designated representatives who report for program matters to the Program Manager. Led by the Program Manager's office, effort to be accomplished is documented in a series of plans which are controlling documents. Control is accomplished through reporting progress versus plan in reports and meetings, and continuous management involvement in and leadership of the work. Key plans are as follows:

SEPARATELY PREPARED PLANS

Program Plan - Summary plan for overall accomplishment of Phase C.

Management Plan - Plan for Management of the Program.

Management Control Plan - Plan for control and accomplishment of each task.

Documentation Plan - Plan for generation and control of Phase C documents and generation of Phase D Documentation.

Make or Buy Plan - Plan for phase C make or buy and source selection activities plus preparation of Phase D plan.

Test Plan - Plan for generation of a complete Phase D test plan covering all testing activities.

Reliability and Quality Assurance Plan - Plans for Reliability and Quality Assurance activities in Phase C and generation of Phase D plans.

Specifications Plan - Plan and preliminary specification tree for preparing preliminary CEI and other specifications during Phase C.

PLANS INCLUDED IN PROGRAM PLAN

Manufacturing Plan - Including manufacturing planning and facilities planning in Phase C, and Phase D plans)

System Safety Engineering Plan - For Phase C activities and Phase D plan.

Logistic Support Plans - Including: Maintainability Plan and Logistics Plan, Phase C

2.2.1.3 Planning

A significant part of the Phase C effort is generation of a group of complete and realistic planning documents for Phase D. For maximum value this effort is accomplished by those managers, technical contributors, and supporting specialists who are directly involved in the work. These planning documents include:

Program Plan (Top, Summary Plan)

Management Plan

Engineering Plan

Integrated Test Plan (Including both Development Test Plan and Qualification Test Plan)

Support Equipment Development Plan

Training Plan

Quality and Reliability Program Plans

Facilities Plan

Make or Buy Plan

Configuration Management Plan (Including Specification Planning)

Documentation Plan

Manufacturing Plan

Logistics Plan

Mass Properties Control Plan

Maintainability Program Plan

Integrated Electrical System Design Plan (Including both Power and Electromagnetic Control Plans)

Interface Control (See Section 2.4.6)

Safety Plan

2.2.2 METHOD FOR PHASE C WORK STATEMENT COMPLIANCE

An important aspect of the GE Phase C effort is assuring full compliance with the Work Statement, the document which embodies the customer's needs and desires-the reason for the contract. This involves both planning and control.

2.2.2.1 Planning

In response to the Statement of Work, full plans for Phase C are laid down.

2.2.2.1.1 The effort required has been translated into a Work Breakdown Structure, the work to be accomplished under each "package" of this structure defined, costed, and scheduled, and products identified to the degree possible in advance.

2.2.2.1.2 For each package of effort, responsibility and accountability (organization and person) is assigned and key contributors identified. Each task, either directly or as a part of a higher level task, is ultimately the responsibility of one of the team members identified under paragraph 2.2.1.2.

2.2.2.1.3 To support and amplify the tasks to be undertaken, a series of plans for specific efforts has been prepared.

2.2.2.2 Control

In accomplishment of the above planning to assure that compliance of the Statement of Work in fact occurs, a series of controls is used.

2.2.2.2.1 The Program Manager signs what is in effect a Contract with each responsible contributor for each task for which he is responsible. This "Contract" defines the task, products, schedules, and funding.

2.2.2.2.2 During performance, accomplishment versus plan (technical, schedule, cost) is monitored through:

- Regular reports to and measurements by the Program Manager's office.
- Frequent regular and special meetings to review progress, problems, and planned corrective actions. These include both internal meetings and those involving the customer.
- Continuous involvement by and communications between the key team members, a very important technique utilizing limited time and a relatively small funded effort but having a large impact upon the quality of the final results.

2.2.2.2.3 Technical and Management review of all products both in process and before final release, assuring full compliance with the intent.

2.2.2.4 Deserving special mention is the control internal channels of direction to assure compliance to the contract: As in-house "customer," the Program Manager assigns all work; he, in turn, assures that the work is in compliance with Contractural scope as defined and controlled by the Contract Administrator.

2.3 ORGANIZATION

2.3.1 SPACE SYSTEMS ORGANIZATION

The General Electric Company has established the Space Systems Organization within the Missile and Space Division, incorporating the most significant Space Systems capability that could be assembled within the Company. The IMBLMS team for Phase C and D is established within the Space Systems Organization and members of this team are employed in the Phase B study effort.

Figure 2-1 shows the corporate position of the Space Systems Organization reporting vertically to the President. The Space Systems Organization is advantageously situated within a family of business activities with demonstrated space competence and draws on the Division's resources for skilled manpower and specialized facilities as required for IMBLMS.

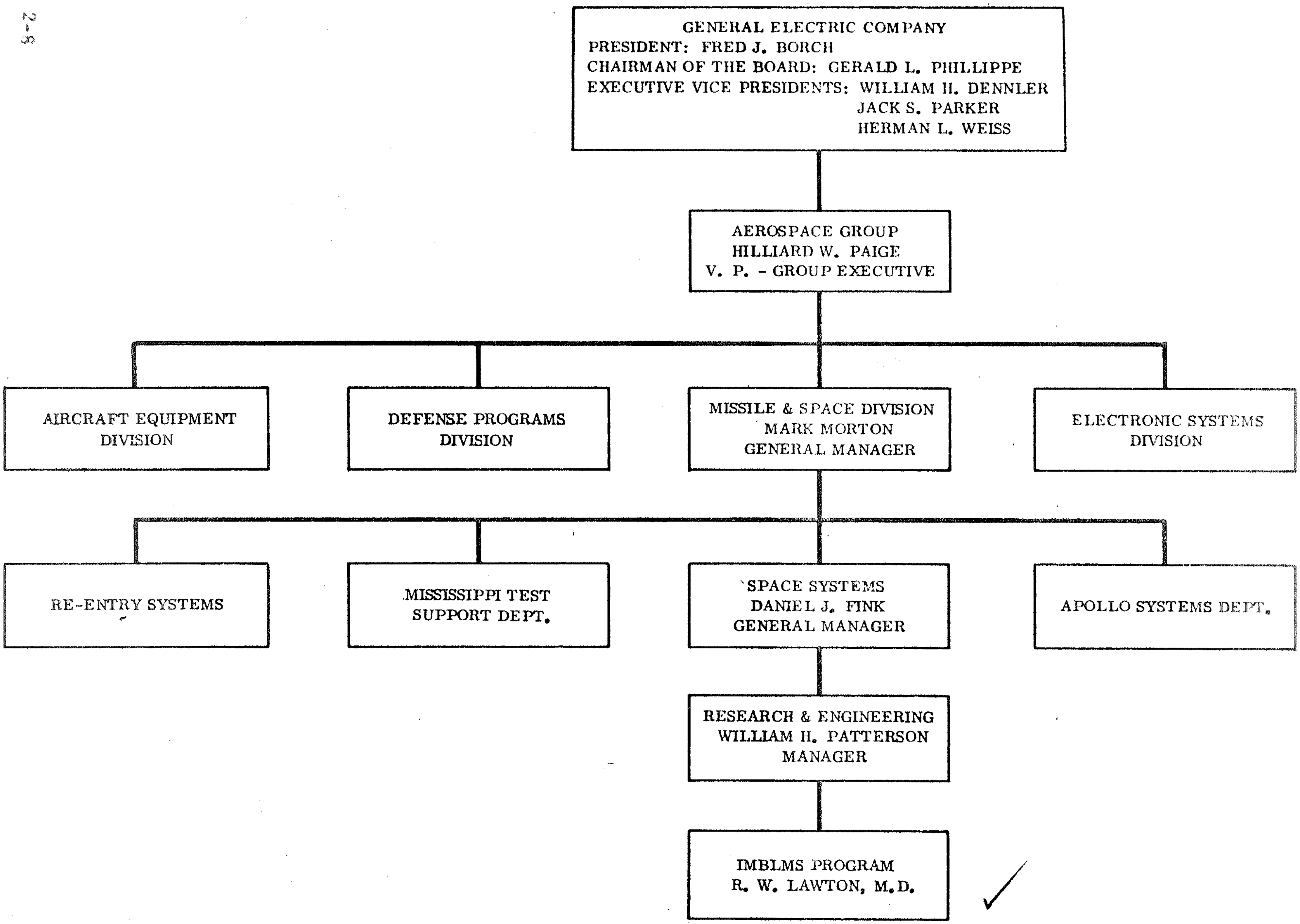

Figure 2-1. Space Systems Organization in the General Electric Organization

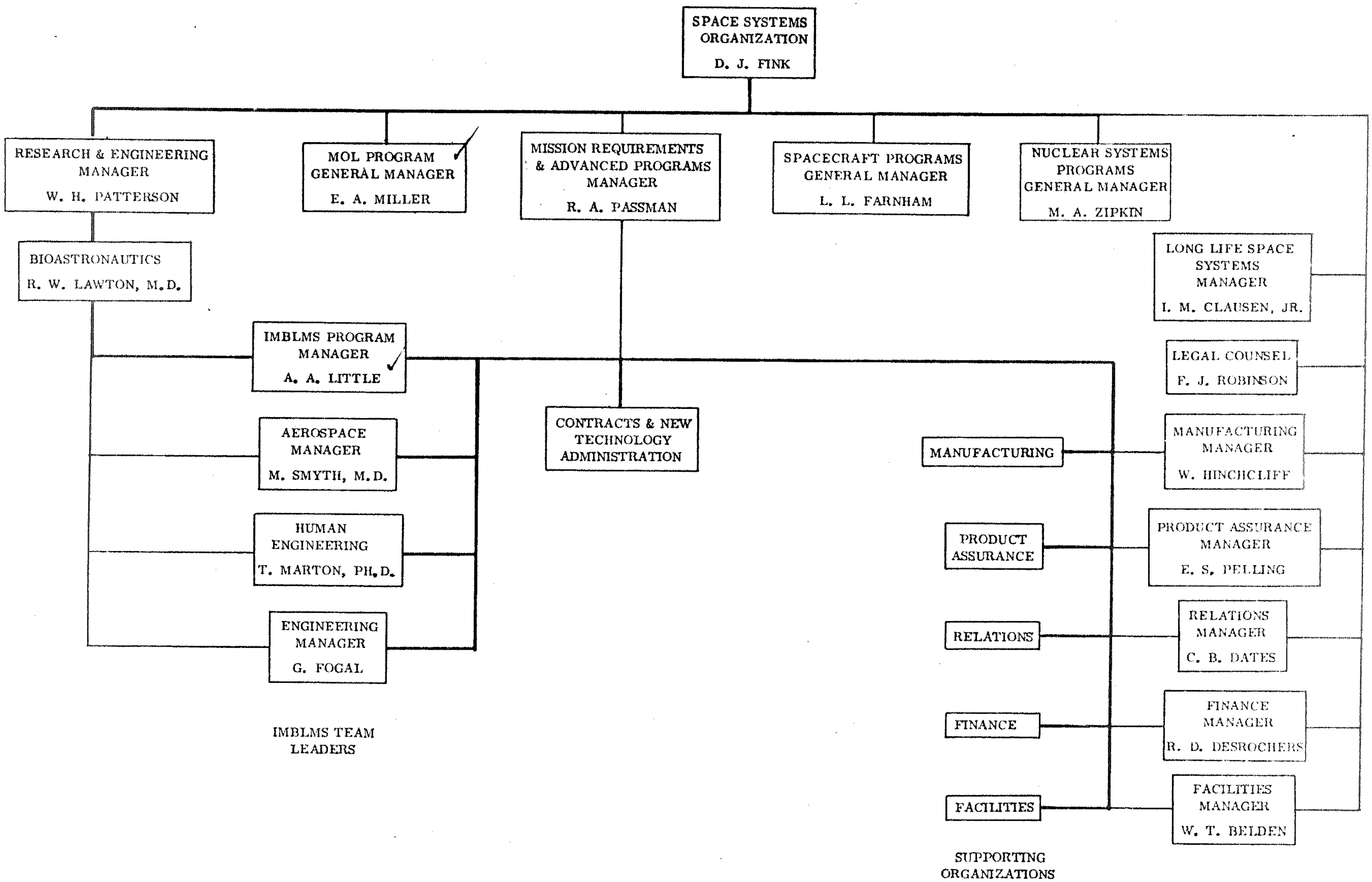

Figure 2-2. IMBLMS Phase C Organization

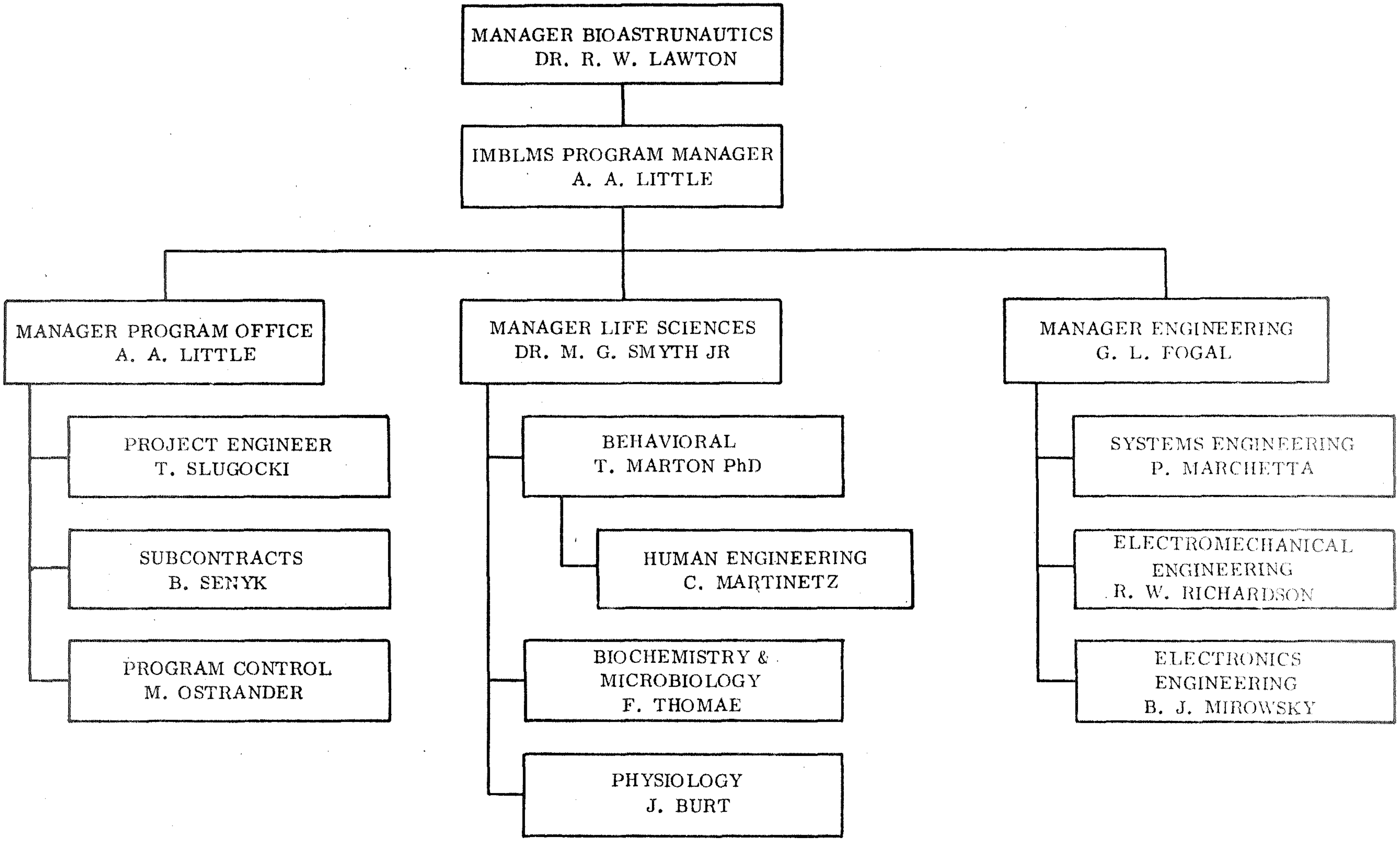

Figure 2-3. IMBLMS Phase C Program Organization

2.3.1.1 IMBLS Program

Reporting to the Manager, Research and Engineering Operation, is R.W. Lawton, M.D. who is responsible for the IMBLMS Phase B Study and will be responsible for the Phase C Program. Dr. Lawton draws upon the resources of the Space Systems Organization as required for the IMBLMS effort.

2.3.1.2 IMBLMS Organization

The Management Philosophy for IMBLMS is based upon two basic premises.

a. The organization depends on the job to be done. Thus the organizations for Phase C and Phase D differ.

b. For maximum effectiveness, a program such as IMBLMS needs both the full-time attention of responsible leaders and key contributors provided by projectized organization and the availability of many specialists provided by other functional groups on an "as required" basis.

In Phase C the emphasis is on analysis, preliminary design, and planning by a relatively small group of closely knit contributors plus contributions as needed from specialists elsewhere. The Phase C organization is shown in Figure 2-2.

a. The "hard core" team will operate under Dr. Lawton and will largely be physically located in a team area (See Figure 2-3).

b. The Program Manager will be a part of this team, acting as Dr. Lawton's deputy to conduct the program. (If a back-up mode is required, Dr. Lawton would act as Program Manager until a suitable replacement is designated.)

c. Contributions from other sections will be obtained on an as-required basis; each section has identified key personnel to support the effort directly and draw on the section's resources as required.

2.3.1.3 Role of the Program Manager

The Program Manager and his staff are directly responsible for conduct of the program. His overall functions include:

a. Maintaining coordination with the customer and translating customer program direction into internal direction.

b. Assigning responsibilities to and funding of functional operations.

c. Planning, integrating, measuring and controlling all program tasks.

2.3.1.4 Key Personnel

Resumes of key management and technical personnel are shown below. More detailed information on these personnel are shown in Section 5.3 of Vol. III.

Name/Title	Education	Experience
R.W. Lawton, Manager, Bioastronautics	M.D., Cornell Medical College, 1944. BA, Dartmouth College, 1942	Served as Manager Life Support Systems for the Department/Division since 1959, supervising activities in bioscience, human factors, life support equipment and bioinstrumentation. Former head of Physiology Division of the Aviation Medical Acceleration Lab., NADC, Johnsville, and Associated Professor of University of Pennsylvania School of Medicine.
A.A. Little, IMBLMS Program Manager	MBA, Industrial Management, Temple University, 1957. MS Mechanical Engineering, University of Pennsylvania, 1950. BS, Aero Engineering, MIT, 1946.	IMBLMS Program Manager; responsible for planning, control and integration of the IMBLMS effort. 1966-1967 Manager of Integration and Evaluation Engineering in MOL Department. Prior to this headed the proposal effort for GE-MOL's experiment integration role in the engineering development phase and served on the contract negotiation team with responsibility for flight equipment.
M.G. Smyth, Jr., Manager, Life Sciences	M.D., University of Pennsylvania. BA, Rice University.	In 1962 was Director of Research and Development at Smith, Kline Instrument Co., responsible for the development of new medical instrumentation devices. Formerly was Clinical Research Director at Smith, Kline and French Laboratories.
G.L. Fogal Manager, IMBLMS Engineering	MS, Mechanical Engineering, University of Maryland, 1954. BS, Mechanical Engineering, University of California, 1941.	Since 1959 was Manager of Life Support Engineering responsible for life support equipment development for SPURT, Discoverer, and Biosatellite plus responsibility for life support system and component aspects on Apollo, MTSS, GSS, MOL, and Lunar Roving Vehicle studies.

Name/Title	Education	Experience
T. Marton, Behavioral Sciences	Ph.D., Princeton, 1962. Certificate on Prosthetics from UCLA in 1953. MS, New York Univ, 1951. BS, New York Univ, 1949.	Has included work in such areas as; manned tests for OSS and MOL operations, human-factor design and performance reliability during the Apollo mission, mobility evaluations via pressurized space suits, and prolonged weightlessness. Research at Princeton covered various emotional and physical aspects of psychological and physiological human behaviors.
F.W. Thomae, Jr, Biochemistry and Microbiology	MA, University of Texas, 1954. AB, Brown University, 1950.	Presently responsible for studies on sampling, analysis, and preservation of biological materials during space flight. Formerly Research Scientist at Radiobiological Laboratory of University of Texas, working on modifications of clinical methods for use on small animals, hematological studies, and enzyme assys. Participated in a variety of programs in Life Sciences Section of LTV Astronautics Division.
T.C. Slugocki, Project Engineer	BSEE, V.P.I., 1951.	As Project Engineer, Air Force Space Program (classified) responsible for providing program office engineering leadership in planning and coordinating technical integration activities including interpretation and application of government and associate contractor's policies, objectives and requirements. Responsible for system integration among contractors and customer including required documents, AGE and field operations.

Name/Title	Education	Experience
M.H. Ostrander, Program Control	AE(JP), California Institute of Technology, 1951. BS(EE), U.S. Naval Post-graduate School, 1950. BS, Naval Engineering, U.S. Naval Academy, 1941.	As Manager, Flight Operations Biosatellite Program, planned and implemented program launch, on-orbit and recovery operational requirements, documents and activities. As Manager Support Operations, planned and managed the orderly disposition of personnel and material during final stage of Air Force Space System Program. As Manager, Systems Integration, coordinated spacecraft recovery subsystem technical and operational requirements with the on-orbit and recovery forces.
B.M. Senyk, Subcontracts	MBA, Temple, 1964. BS, Drexel, 1957.	On MOL Program, responsible for managing subcontract, including vendor evaluation and selection and technical requirements. Responsible for subcontractor's performance schedule and cost. On NIMBUS and OAO programs performed as development and reliability engineer. With UNIVAC was responsible for design and development of computer electromechanical subsystems.
P. Marchetta, Manager, Systems Engineering	BS(EE), Rensselaer P.I. 1948. AB(Math), S.C.N.Y., 1943.	As Manager Orbital Systems was responsible for defining the on-orbit sequences and data flow for the experiment interrogation in the MOL Program. Directed the integration, testing and evaluation of the ground station equipments to acquire and process the cloud cover and telemetry data from the first NIMBUS spacecraft. Eighteen years experience in electrical systems including electrical systems engineer on ADVENT and several air defense programs.

Name/Title	Education	Experience
R.W. Richardson, Manager, Electromechanical Engineering	MBA candidate at Drexel Institute of Technology. BSCE, Drexel Institute of Technology, 1958.	Presently Configuration Design Engineer for Advanced Manned Systems Engineering Projects responsible for configuration design requirements and supporting documents for advanced spacecraft configurations. Previously Senior Structure Engineer on Apollo Project for North American Aviation Company, responsible for the analytical verification of vehicle structural integrity.
B.J. Mirowsky, Manager, Electronics Engineering	BSEE, University of Missouri, 1951.	Currently responsible for design leadership in electrical, power and electronic systems for advanced manned spacecraft applications. Designed the recovery electrical and electronic subsystems for the first successful satellite re-entry vehicle on Discoverer Program. Previously worked in conjunction with NASA, MSC, and KSC personnel in the system development of the digital Automatic Checkout Equipment.
C. Martinetz, Engineering Psychologist	MA, Psychology, Temple, 1964. BS, Physics/Math, St. Francis, 1958	Responsible for human engineering of the ground support equipment for Atlas, Titan and Minuteman weapon systems including task and timeline analysis, field verifications, and system maintenance plans. Participated in MOL, NAVMOL and AAP proposals in capacity of human factors engineer. Provided configuration management information (AFSCM 375-5, NPC 500) relative to man/machine function.
John F. Burt Jr, Crew Systems Engineer	MS, Biomedical Engineering, Drexel, 1966. BS(EE), Villanova, 1964.	As crew systems engineer - Manned Orbiting Laboratory Department designed physiological monitoring systems for underwater and space suit application and electrical control systems for underwater life support systems. Participated in underwater zero-G simulations and design of deep diving underwater systems.

Name/Title	Education	Experience
M. Traite, Manager, Instrumentation Engineering	BS(EE) Cooper Union	Director, Biomedical Engineering, Diagnostic Research with OrthoPharmaceutical Corporation. Engaged in engineering research on instrumentation for measurements of blood plasma, detection of blood compatibility, and for general doctor's office use. Research Specialist, Bioinstrumentation Group, Bioastronautics with Lockheed Missiles & Space Co. Delineation of instrument requirements for space flight biomedical measurements. Chief Project Engineer, Physiological Instruments Group with Beckman Instruments, Inc. Development of sensors and accessory instruments for measurement of blood pressure, blood oxygen, and respiratory oxygen. Senior Engineer, Medical Instruments Group, R&D Lab. with Gulton Industries, Inc. engaged in the research, design, and development of transducers, circuits, and systems associated with blood pressure, intercardiac, etc. instruments.

2.3.2 ASSOCIATES, CUSTOMERS AND INTERFACE CONTROL

Design and control in the areas of the Spacecraft and IMBLMS interfaces must be accomplished by a means that will ensure proper and timely design integration.

The overall IMBLMS assembly will be designed in modular segments which can be adapted to the three specified spacecraft with a minimum of modification or requalification required: (1) the Orbital Workshop (OWS), (2) the Lunar Landing Module (LM), (3) the Refurbished Command Module (RCM). The modular segments will be designed to interface with the three spacecraft with respect to weight, shape/volume, electrical power requirements, and auxiliary services for liquids, gases, coolants, data transmission and command and control.

A Schedule Interface Log (SIL), similar to that employed on the MOL Program, will be used for the IMBLMS Program. This log is a listing of interface between the IMBLMS Program and AAP participants. All interface events required for the various aspects of the design, and later for the development, are recorded as soon as the need is identified. The requestor, description of the interface, need date, source of the event, promise date, action taken or needed and person responsible are all logged. Receipts are channeled through the log and to the requestors. Operation and integration of the Schedule Interface Log will be the responsibility of the Program Manager. Defining and documenting all significant interfaces and the conduct of regular reviews of these ensures design integration and permits program management to keep delays to a minimum.

Interface specifications will be prepared as applicable. These specifications will record design agreements which provide the means to define, evaluate, and control all mutually interdependent design parameters and to assure the physical, functional, and operational compatibility of the system, its control end items, and other elements making up the system. These specifications will be prepared in conformance with M200B, Chapter V, of the Defense Standardization Manual.

General Electric will be responsible for assuring that functional and physical interfaces between equipments within its design cognizance and equipments under the cognizance of other contractors are documented in formally issued and controlled interface specifications. Relationships between NASA procured specialized equipments and IMBLMS will be a part of such interface specifications.

In Phase C, design layouts will be provided to show how the total IMBLMS modular segments, or portions of the total, could be installed in the three spacecraft. Interface diagrams, drawings, and specifications will be provided to establish interface requirements and preliminary designs for installation and interconnection of the IMBLMS equipment with the three spacecraft. The primary interfaces will include the mechanical installation and mounting designs, the electrical power interfaces, the command and control interfaces, the electrical and electronic interfaces for communications, telemetry, data handling, monitors and displays, and the support services interfaces. The support services interfaces will include water, gases, vacuum, coolants, waste disposal, etc.

The interfaces with the different spacecraft will be designed to provide a maximum of commonality in usage of connectors and mounting hardware. The designs will include provisions to assure crew access for maintenance and repair and human engineering considerations with respect to actual astronaut hookup of the measurements/spacecraft interfaces.

Crew safety provisions will be included in the interface designs. Material selection and usage for the designs will be compatible with the existing requirements for the three spacecraft on which the IMBLMS equipment will be used. The interfaces of the IMBLMS equipment with the spacecraft electrical, mechanical, and thermal systems will be designed to assure that the installation of this equipment will not jeopardize the crew safety or mission success probability of the manned spacecraft.

2.3.3 SUBCONTRACTORS

The General Electric Company Space Systems Organization is commited to assemble the strongest possible technical team available to execute the IMBLMS Program. In addition to GE personnel, this team contains selected individuals and companies from the medical and aerospace industries. Pursuant to the philosophy of maintaining the capability·openly to select the strongest support available, General Electric has not at this time any firm plans to use funded subcontracts in Phase C (other than use of consultants). In general, it is planned to obtain the best subcontractor expertise in specific areas; General Electric may provide assistance and guidance in orienting subcontractors to the methods and demands of the space business. A number of potential key supporting personnel and organizations have been contacted and surveyed and have expressed willingness to work with General Electric on the IMBLMS Phase C Program. If it becomes appropriate during Phase C to enter into any funded subcontracts, it will be done in accordance with established procedures, through reprogramming of available funds and with cognizant contract monitor approval.

The tasks that these persons and companies may be asked to perform in their particular offerings in Phase C will, in general, be as follows:

a. Perform preliminary design on equipment selected for IMBLMS and provide specifications and parameters (weight, volume, power, interfaces) of this equipment for GE use in performing system design, packaging, and other technical tasks.

b. Perform preliminary design, layouts, schematics, and estimates of the critical parameters for the equipment now only in conceptual or breadboard form, but selected for IMBLMS.

c. Provide performance parameters and safety, reliability, and interface requirements where General Electric needs supplier information to prepare procurement specifications.

To provide continued emphasis on surfacing the best subcontractor support for Phase D, an experienced Subcontractors Manager has been assigned full time to the IMBLMS Program Manager.

2.4 MANAGEMENT AND CONTROL FUNCTIONS

2.4.1 WORK BREAKDOWN STRUCTURE AND TASK DEFINITIONS

The Work Breakdown Structure (WBS) is based upon the nature and outputs of the program and the organization of the work. It is designed to provide complete coverage of all relevant items, plans, schedules and costs; and is mutually exclusive in the definition of the work elements.

The WBS for the Phase C-Design shown in Figure 2-4, is expandable and adaptable to the succeeding Phase D work.

The WBS is defined to Level 3. There are four Level 1 Subdivisions of Work (SOW) which are identified as:

- Program Management
- Systems Engineering
- Design Engineering
- Phase C Support and Phase D Proposal Support

Each of these subdivisions is further divided into two or more Summary Tasks and each of these into two or more Work Package Tasks. Each task has been defined with regard to:

- Task description
- Responsible individual
- Schedule dates
- Products
- Manpower

It is the monitoring and analysis of the basic elements of the Work Package Tasks which will provide program control.

Further definition of the content of each of the Subdivisions of Work is given in the "Management Control Plan", Section 4 of Volume II - Management of the Phase B Final Report.

2.4.2 FUNDING, COST AND SCHEDULE CONTROL

The Program Manager issues internal "contracts" for all work package tasks. These internal documents include technical composition, cost, schedule requirements, and outputs. They are negotiated with and accepted as contractual type documents by responsible parties who, in turn, may contract with other performing parties for their assistance, and, in turn, issue funding control documents to their subordinate groups. Thus, a complete chain of funding schedule and technical control is established. This funding method is done through a presently operating system of Program Funding Instructions (PFI). Weekly reports of expenditures against the PFI's as compared to budgets are obtained; as are milestone reports of achievements versus budgets through the Integrated Milestone Reporting System (IMRS).

These, together with examination of the outputs for technical content permits appropriate management control to be exercised in event of any significant deviations. Discussion of these existing management cost, schedule, and technical control techniques are contained in sections 2.2.2.2, Section 3, and Section 4 of Volume II - Management Phase B Final Report.

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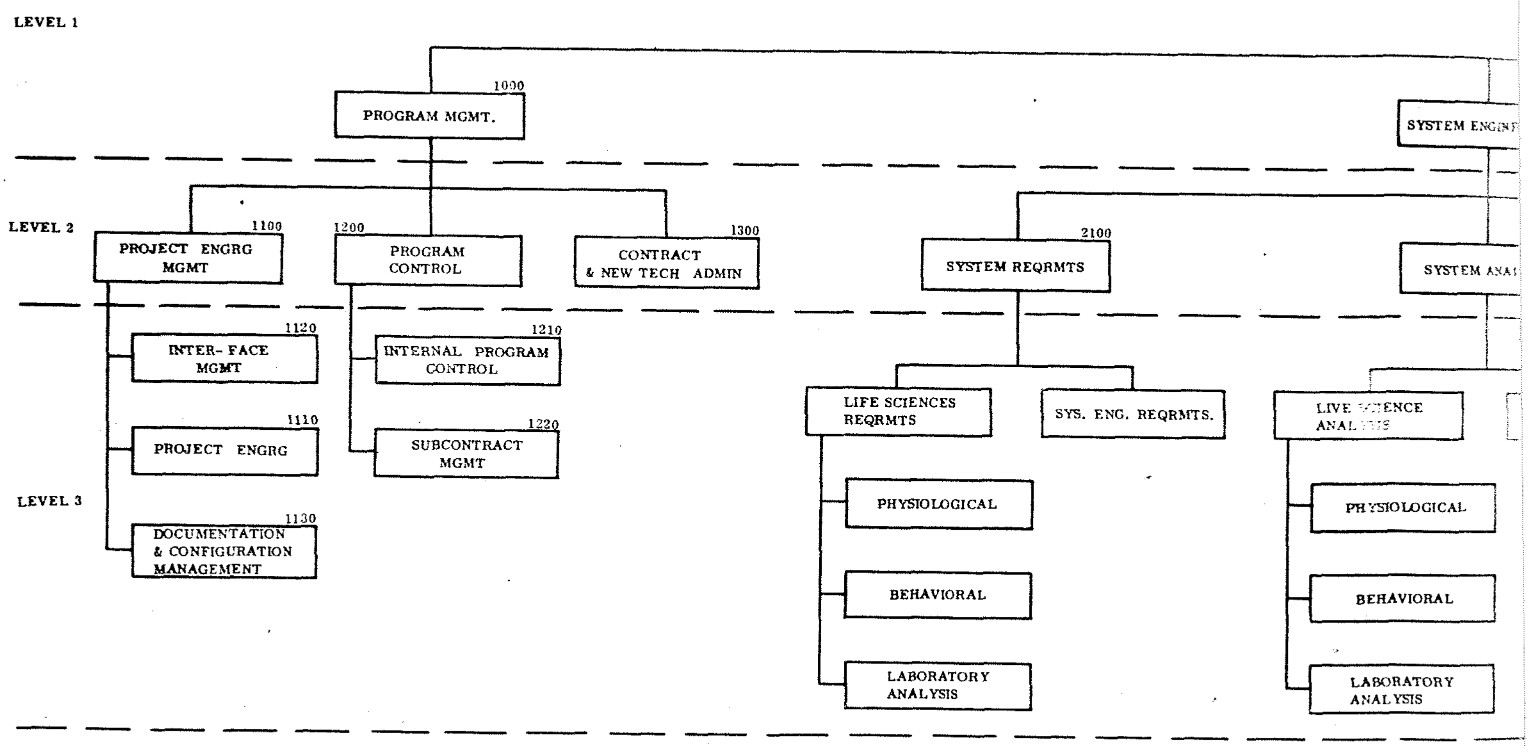

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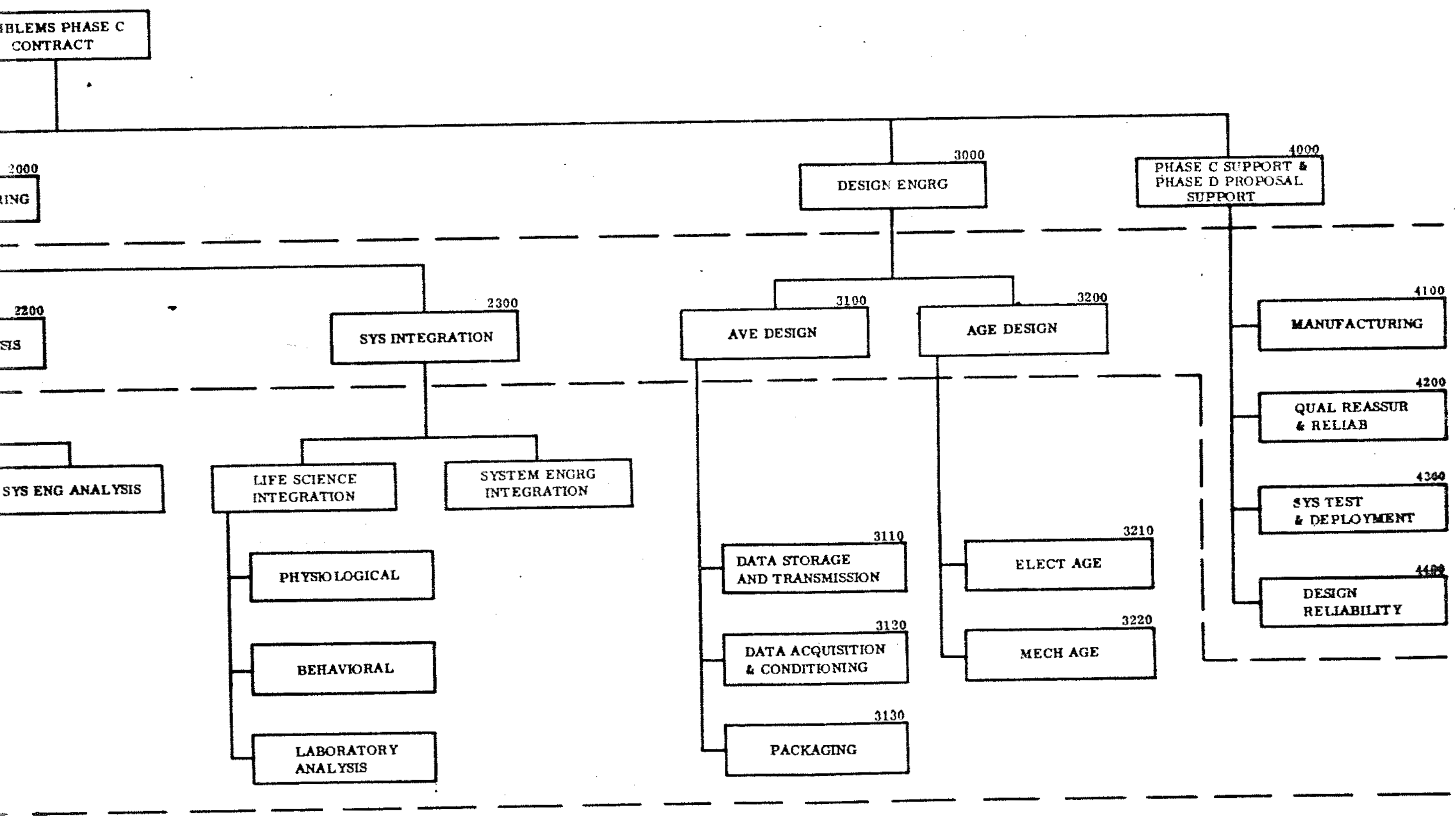


Figure 2.4. IMBLMS Phase C Work Breakdown Structure

2.4.3 TECHNICAL DIRECTION

The internal technical direction of the program activity is initiated by the task definitions, as agreed to between the Program Manager and the performing Organizations, in the PFI's. Continuing technical direction is exerted by the Program Manager, both in and following the Weekly Program Meetings. These meetings between all principal managers and contributors assigned to the program provide vital communications and opportunities for problem identification and solution.

Day-to-day contact between the Program Manager and key contributors will of course provide significant continuing direction.

Customer technical direction of the program will initiate from the Phase C Contract Work Statement plus revisions scheduled to the measurement requirements. Informal contacts by technical specialists with appropriate counterparts in the NASA organization will aid the contractor in his interpretation of requirements and in being responsible to the needs of the customer. The oral mid-term review will provide an important check-point in the course of the program. The official customer direction channel is described in 2.2.2.2.4.

2.4.4 DOCUMENTATION

The documentation plan is responsive to the objectives and requirements of document management pertinent to a program of the size and scope of the IMBLMS Phase C contract and of sufficient depth to form the basis of a document management plan for IMBLMS Phase D. The key features of the plan are:

- Document management is established as a management support operation. The generation, preparation, production and reproduction of documents remain the responsibility of the appropriate line operations.
- Document Management encompasses not only the acquisition and management of documents across contractural interface but also the management of in-house documents.
- Requirements for documents are established by the users thereof and are validated on the basis that the documents identified are essential to the effective accomplishment of an authorized work package.
- Existing facilities and operating procedures are used to the maximum extent.

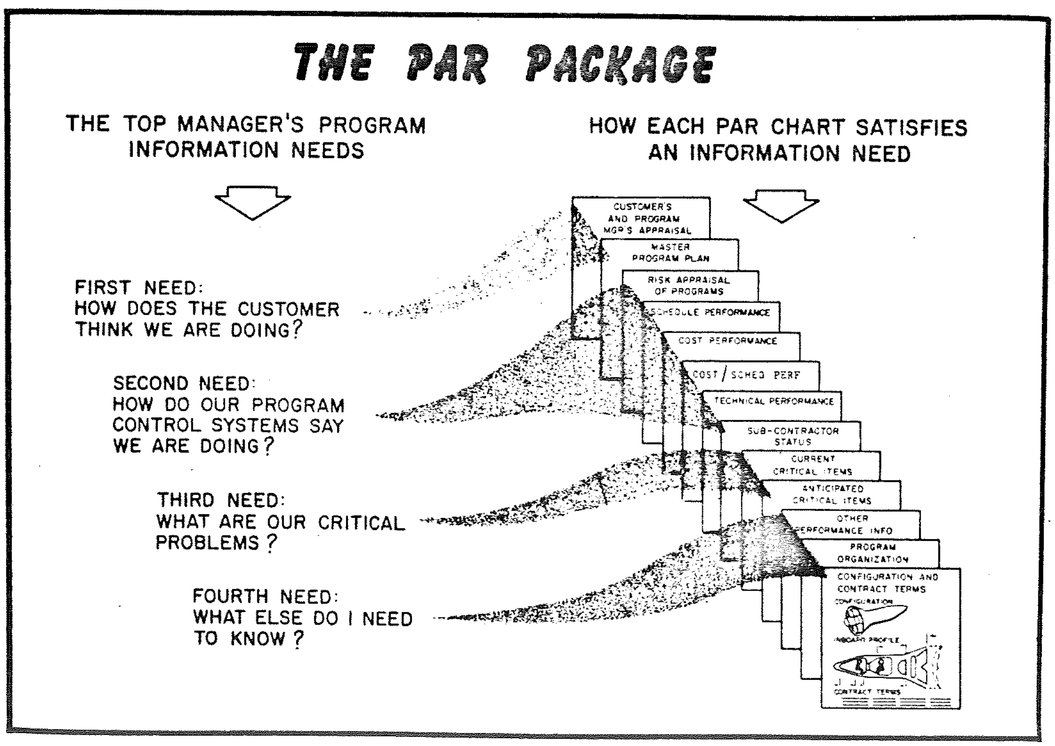
Further definition of the documentation requirements and plans are given in Section 5 of this volume.

2.4.5 MANAGEMENT REPORTING

Top management will be regularly informed of the conduct of the IMBLMS program by use of the Program Appraisal and Review (PAR) System. During the Phase C portion of the program

PAR reports will be scheduled with the MOL Program General Manager. In the succeeding phase PAR presentations will be made to the Division General Manager. Top management in the General Electric Company is vitally interested in the conduct of the IMBLMS program, knowing that successful performance thereon is the key to customer satisfaction. This interest is demonstrated by the many methods in use to integrate the top manager's broad experience and multi-program view with the activities on each of the current programs. These methods vary from bi-weekly program progress summaries to the Vice President at Group Executive level to the more detailed information and control systems for the Vice President at Division level and the Department General Manager; systems such as the Program Appraisal and Review System (PAR).

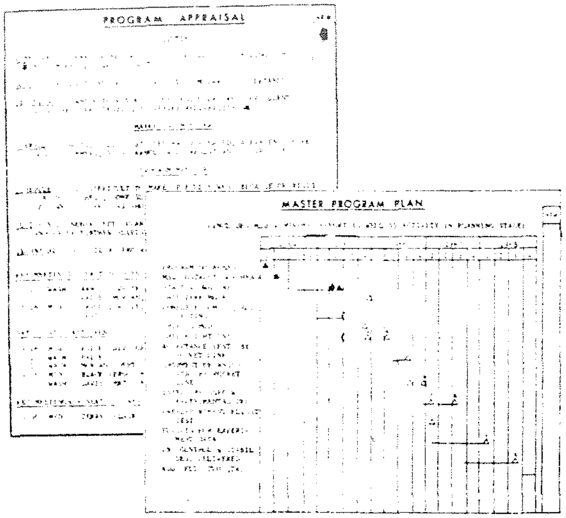
PAR is a program information reporting system to meet the specific needs of top management. The system was developed at the Missile and Space Division early in 1962 where it has since been in constant use. It is a simple, low cost method of providing the top manager with information on the significant programs within his responsibility. The PAR system utilizes a structured format whereby the myriad of existing program data are filtered to give the top manager specific program information to satisfy his needs in a form which is uniform across all programs. The four basic needs of the top manager which are satisfied by the structured PAR format are shown in the figure below.



Detailed support and elaboration of these basic needs is outlined on the following pages.

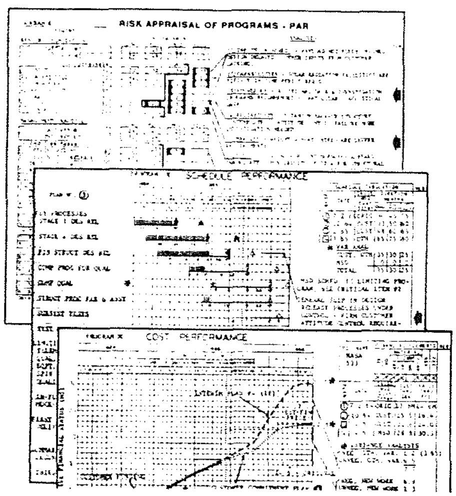
This PAR system, in its entirety, is tailored to appraise and review large, multi-faceted programs; yet by modification and simplification - possibly some deletions - is applicable to programs of lesser size and lesser complexity. It is in this light that it is to be applied to the different phases of IMBLMS. Phase C, lacking hardware and its attendant breadth and depth of program detail will not require as full blown PAR presentation as required in Phase D; therefore, those sections that are oriented toward the larger programs and are not meaningful in Phase C will be curtailed or omitted.

Informal, oral presentations are made monthly on each program by the Program Manager, permitting in-depth questions on selected areas. The top manager utilizes the information from the system for person customer interactions, corporate communications, and for implementing and integrating actions.



The PROGRAM APPRAISAL CHART tells the top manager both what the Customer says and what the Program Manager says about General Electric's schedule, cost and technical performance on the program. Direct quotations from named Customer personnel are required.

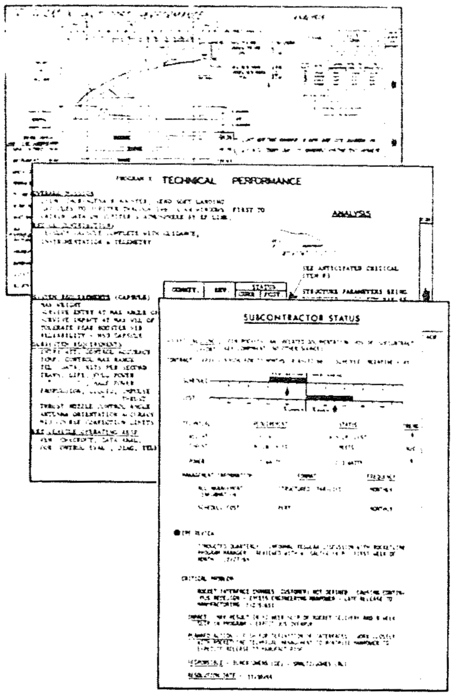
The MASTER PROGRAM PLAN places GE's portion of the program in context with the Customer's total program. This with the Program Appraisal Chart then serves as an indicator to the top manager of the need for his personal involvement.



The RISK APPRAISAL OF PROGRAMS CHART shows the risk levels associated with resource limitations and defines actions to deal with the risks, it also shows the extent to which low risk management practices are being adhered to; both in comparison to plan. The appraisals are made by the responsible individuals with the aid of checklists.

The SCHEDULE PERFORMANCE CHART is tailored to early detection of schedule performance problems--the specific chart format used depending on the maturity of the program. Schedule performance is measured by counting only work tasks completed against a fixed commitment plan, using a technique called "SPERT." This focuses management attention on operation and path problems.

The COST PERFORMANCE CHART compares actual and planned costs with the cost commitment made by General Electric to the Customer, and includes information on funding and manpower. A variance analysis between anticipated costs and the commitment is detailed in terms of the factors that might cause the variance to occur.

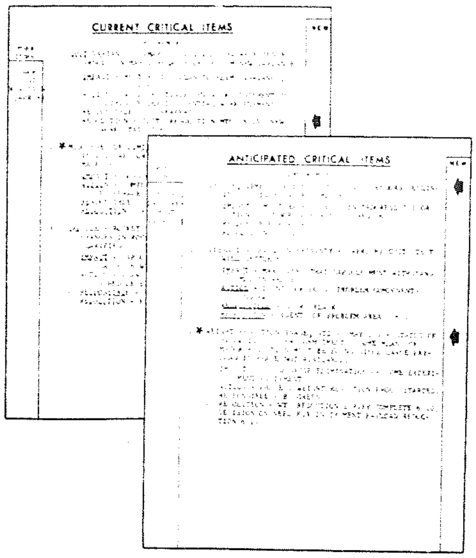


The PERT COST PERFORMANCE CHART is a graphic combination of the Standard PERT Cost Management Summary Report and Cost of Work Report. It shows overall program status as well as bar summaries of status of each end-item and each responsible organization providing a correlation between schedule, cost, and organizational performance.

The TECHNICAL PERFORMANCE CHART itemizes the critical technical performance factors of the program, providing for each the performance number to be met according to the commitment made to the Customer. These commitments are compared with actual or currently planned performance and variances are explained on the chart.

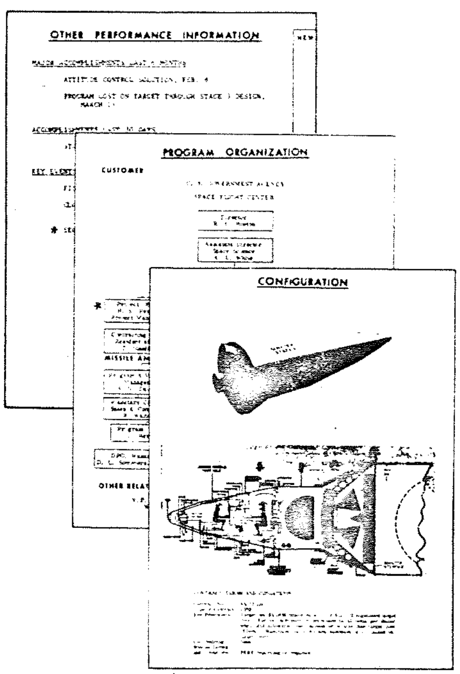
The SUBCONTRACTOR STATUS CHART displays the current status of each major and/or critical subcontractor by summarizing the correlation of program status (schedule/cost/technical) and indicated trends. Contractor performance evaluation (CPE) information is reviewed and critical subcontractor problems are analyzed.

The six (6) chart formats are used to satisfy the need to obtain detailed program performance information.



The CURRENT CRITICAL ITEMS CHART presents the top manager with the three most critical problems on the program, with an analysis of each problem.

The ANTICIPATED CRITICAL ITEMS CHART stimulates the Program Manager to look ahead and to forecast where he is likely to have difficulties in the future. These two Critical Items Charts provide the top manager with his most important opportunity for personal action and decision.



The OTHER PERFORMANCE INFORMATION CHART lists Major Accomplishments and future Key Events.

The PROGRAM ORGANIZATION CHART shows persons (Customer, internal or subcontract) likely to contact or be mentioned to the top manager.

The CONFIGURATION AND CONTRACT TERMS CHART provides a photograph or sketch with component layout and major contract terms and conditions.

These three (3) charts provide general program knowledge essential to the top manager's communication with his superiors and with top level Customer management.

The fact that General Electric top management is looking regularly and frequently at the status of each major program helps keep the program team on its toes, and has contributed to improved program performance.

2.4.6 INTERFACE CONTROL

Interface control to be implemented during Phase C takes into account the following features of the IMBLMS Program:

a. Phase C is a definition phase conducted by two contractors engaged in independent, parallel efforts and interfacing with a single NASA center.

b. Phase D transition to a hardware program - where the IMBLMS contractor interfaces with several spacecraft prime contractors, unique NASA procured equipments, and with experiment contractors - requires implementation of a complete configuration management system based upon NPC 500-1.

c. Due to the size and nature of Phase C, elements of the complete configuration management system can be economically introduced in Phase C to provide the required interface controls and thus assure an orderly, efficient transition from Phase C to Phase D.

The Interface Control Plan for Phase C is designed to achieve compatible and timely definition of design interfaces with:

- The IMBLMS Performance/Design Requirements Specification (program requirements baseline) and subsequent NASA technical direction and intent.
- Requirements of the experimentors
- Requirements of the spacecraft which are potential IMBLMS carriers
- NASA procured specialized equipments
- Flight crew and mission operational requirements
- GSE and facilities requirements

Part I CEI Specifications, interface control drawings, and changes to issued contractual interface documents will be prepared and submitted using NPC 500-1, Apollo Configuration Management Manual, as a guide. NASA approval of a change will constitute authority to implement the change. The IMBLMS contractor will be responsible for the preparation, maintenance, accounting and distribution of interface documents for which custodianship has been assigned. For interface documents prepared by associate contractors, it is recommended that NASA procedures provide for a concurrence signature by the IMBLMS contractor prior to submittal to NASA for approval.

Requests for interface meetings with NASA, experimenters and associate contractors will be submitted prior to meeting (10 days is suggested as reasonable notice) and will be accompanied by a proposed agenda. Interface meetings will be convened only after NASA approval. Minutes will be prepared by the assigned chairman and signed by designated representatives of the participants prior to conclusion of the meeting. The chairman will distribute the minutes within 5 working days after the meeting. Agendas and minutes for the Interim Report Oral Briefing and the Final Oral Briefing will be prepared using the above procedures. Interim and Final Written Reports will be submitted per contractual requirements.

A Schedule Interface Log (SIL) will be used as a tool for integrating and monitoring all interface events. The SIL documents required interface events (including action items resulting from interface meetings) as soon as identified and reports their status to NASA and associate contractors on a monthly basis. Log entries are comprised of interface item description, requestor, need date, promise date, action taken or needed, and the responsible contractor. Receipts are channeled through the log and to the requestors. Log preparation, maintenance, and distribution will be the responsibility of the Program Manager. Regularly scheduled SIL reviews will assure management visibility and timely action item follow-up.

As part of the Phase C effort, GE will prepare and submit a Phase D Interface Control Plan.

2.5 DESIGN APPROACH

2.5.1 TECHNICAL REQUIREMENTS AND SOLUTIONS

The complete IMBLMS is intended as a service and measurement capability supporting any of the currently-identified experiments but sufficiently broad in scope so to accommodate measurements for as-yet-undefined future experimental procedures. The selection of experiments for any particular mission will be determined by several variables, such as priority of experiment, time available, characteristics and identity of the measurement site, which will influence the programming and grouping of experiments. The General Electric approach to accommodating such diverse experimental measurement requirements is to define a basic measurement capability which would be essential in any experiment combination. Modules of IMBLMS are added as required for the particular, selected group of experiments.

Each experimenter will want to measure the general environment in which his experiment is being performed. Acquisition of atmospheric parameters of temperature, total pressure, gross composition (i.e. oxygen, carbon dioxide, diluents, water vapor partial pressure) plus, perhaps, the "g" level are desirable. Other environmental factors such as light level, trace contaminant concentration, may be required. None of the presently-identified experiment performance areas (LM, MDA, CM, S-IVB) provide a complete readout of the environment. In the LM system, although oxygen concentration is available, neither water vapor concentration nor "g" level is available, and the accuracy of the data that is available may not be compatible with the experiments' needs. As shown in Figure 2-5, a feasible basic

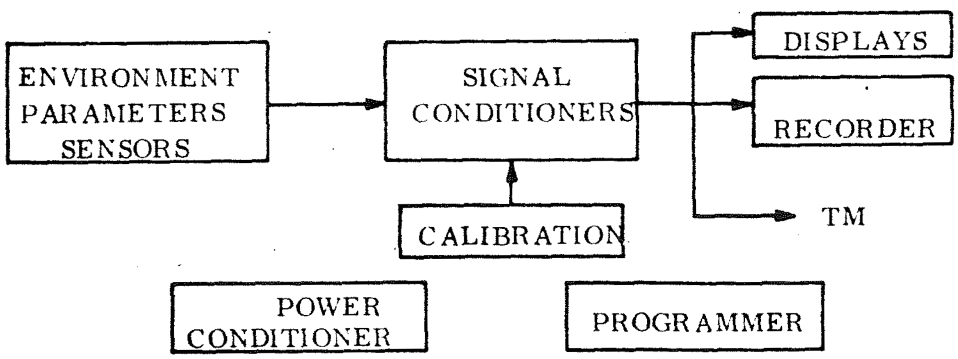


Figure 2-5. Basic Measurement Capability (Environment Parameters)

measurement capability would comprise the modules for environment sensing, power conditioning, signal conditioning, and the data-management complex to provide the necessary measurement of the experimental environment.

Because IMBLMS hardware is multiple-purpose wherever possible and thus capable of supporting more than one sensor, both single-purpose and potential multiple-purpose modules can be identified.

The performance capability of each module must be based on the requirements of the entire IMBLMS assembly. One approach is to make each multi-purpose module capable of supporting all foreseeable measurements. In some instances, this may be desirable. In others, the resulting physical size and weight or other complexity may warrant two or more submodules having the same system function, either identical in capability, or each having a different range of capability. For example, the power conditioning function for the total IMBLMS could be provided by three identical (or similar) power conditioning submodules. If only a few measurements are required for a specific mission, only one of the power conditioning submodules would be used.

Whether a specific system function should be provided by several identical modules or one single module will depend primarily on the range of performance required and the effect of this performance range on physical size and weight. If the performance range is narrow or can be accommodated without significant effect on the size and weight, only a single module per function should be used.

Inherent in the General Electric IMBLM system concept is the definition of a module as a system element which performs a specific system function. Dividing the IMBLMS into "standard" functional modules offers flexibility in meeting specific mission experiment requirements. Only those modules which are required are used, thus reducing size, weight, and cost for that particular mission.

This flexibility of accommodating multiple spacecraft/experiment conditions requires a compatible packaging concept. If each module (or submodule) has an integral support structure, excessive weight of an overall IMBLMS can result. Thus, a support structure which contains all the necessary modules for a specific mission is desired. This overall support container for a specific mission must therefore physically accommodate all of the functional modules with interconnections (electrical, pneumatic, etc.) internal to the IMBLMS assembly. The structural container is thus a unique design for each specific mission. This approach, in addition to minimizing size and weight, permits the shape of the support container to conform to the space available in the spacecraft, a significant advantage for restricted volume spacecraft such as LM and CM. Maximum size, however, will be limited by airlock dimensions and crew handling capability. A maximum size IMBLMS assembly may consist of three substructures (or modular segments) as noted in General Electric's Phase B technical report.

In summary, the General Electric approach to the IMBLMS system concept is to define a minimum (i.e. basic) measurement capability. This basic capability provides measurements of those experiment parameters (i.e., heart rate, blood glucose or status of the environment) which are potentially needed for every medical, biochemical, and behavioral experiment. Additional functional modules are added to this basic capability to meet the total experiment measurement and support requirements as defined for a particular mission.

2.5.2 ENGINEERING PROCESS

Technical management of the IMBLMS effort is set up specifically to provide operation to achieve meaningful results. Two main technical areas are specifically delineated: Life Sciences, because of its importance as a technology to the success of the IMBLMS and because of the importance of detailed technical understanding of the biomedical community and programs affecting IMBLMS, is set up as a main technical entity; Engineering, with responsibility for the derivation of requirements for and carrying out of the hardware design is set up as the other main technical entity. These two technical groups are in turn broken down into subordinate technical groupings in order that the technical content within each is covered by specialized groups providing full attention to the area. Thus, the Life Sciences group, is broken into physiology, laboratory analyses, and behavioral. (The behavioral area, because of the pervasiveness of this technology into other aspects of the program, provides the human engineering support throughout.) The engineering group is divided into 3 sub groups: Systems Engineering, Electrical/Electronic Engineering, and Mechanical/Structural Engineering. Each of these groups is headed by a manager who has a group of full time assigned people reporting to him.

Of particular note is the function of the Systems Engineering group; this group acts to assemble and interpret the technical requirements for IMBLMS including both those stemming from mission and external interface considerations and those coming from the life sciences groups. These requirements then are negotiated as meaningful technical requirements upon the design groups managers. Subsequently, during the progress of the program, it is a function of the systems group to examine the design as it progresses against these requirements and to make necessary modifications in design direction or revisions in the requirements in order to assure a most meaningful product. This ultimately results in a capability report for the qualified system. The contribution of this check and balance system to the best technical system design can not be overemphasized. Within each of the groups described above the manager holds his group accountable for meaningful results just as he himself is accountable to either his higher manager or directly to the Program Manager. This accountability includes such things as leadership, review and buy-off of technical planning, internal review meetings and corrections during the process of the effort, evaluation of personnel and their performance, and a use scheme of technical documentation which is preplanned and proven by experience within the division. Through use of the documentation system, a series of controlled, formally released documents constituting the "Requirements Documentation Package" will be assembled through the course of the Phase C Program. Each of these items is summarily described below. These products of the Engineering process are closely integrated with the Test, Reliability and Quality Assurance activities described in greater detail in other sections of this plan and in this volume.

2.5.2.1 Preliminary System Requirements Document

The system performance and design requirements based on the results of the Phase B studies and System Engineering activities conducted during Phase C will be defined in this specification, prepared in conformance with the requirements for a "Master End Item Specification" as defined in the MSC Supplement #1, Rev. B, dated 26 April 1965, to NPC 500-1, dated 18 May 1964, Apollo Configuration Management Manual.

2.5.2.2 Preliminary CEI Specifications

Preliminary specifications will be prepared in accordance with the Part I portions of the applicable Exhibits (II, IV, V, VI) of NPC 500-1. The performance and design requirements stated therein will be based on and compatible with the performance and design requirements given in the system requirements specification and the functional allocations resulting from System Engineering activities and packaging analysis.

CEI Specifications foreseen at this time include those for:

a. IMBLMS Flight Equipment Total Package (may be more than one set to cover configuration differences between missions.)

b. Operational Support Equipment

    1. Electrical OSE

    2. Mechanical OSE

    3. Trainer

    4. Computer Software

c. Maintenance Ground Equipment

d. On-board Maintenance Equipment

e. Deliverable Functional Prototype

f. Deliverable Mockup

2.5.2.3 Preliminary Test Requirements (Development and Qualification)

The preliminary requirements for development test, qualification test, reliability test and analysis, and their relationships embracing integrated test requirements for component, system and subsystem will be developed during Phase C.

2.5.2.4 Preliminary Environmental Specifications

Preliminary environmental specifications will be prepared to define the expected environments and the levels to which components shall be tested for both qualification and acceptance.

2.5.2.5 Interface Specifications

Interface specifications will be prepared as applicable. These specifications will record design agreements which provide the means to define, evaluate, and control all mutually interdependent design parameters and to assure the physical, functional and operational compatibility of the system, its contract end items, and other elements making up the system.

2.5.2.6 Preliminary Block Diagrams, Preliminary Analysis and Inboard Profiles

These are products of the GE-Space Systems Organization in-place "Stage Release System", as discussed in Section 3 of this Volume. This system provides for formal scheduled release of engineering information meeting pre-planned contents and design tolerances in four successive stages of refinement. By direct application of this stage release system, the requirements in the areas of equipment and subsystem block diagrams, preliminary analyses (i.e. thermal, dynamic, controls, weight and balance, stress, size, power), and inboard profiles will be released as part of the initial or Stage I subsystem release. During Phase C, the design will be released, meeting Stage I release requirements. The pre-Stage I release design review will be carried out as part of the Concept Design Review with the customer.

2.5.2.7 Selected Parts/Materials and Processes Lists

A preliminary Selected Parts List based on program requirements will be developed and used. This list will contain electronic and electromechanical parts and part derating and application requirements. High reliability parts, with the addition of screening and burn-in where applicable, will be used for flight equipment.

Selected Materials and Selected Processes lists will be developed of materials suitable for use on IMBLMS in the spacecraft to be utilized, drawing on both the COMAT data bank and Space Systems Organization experience.

2.5.2.8 Procurement Specifications for Buy Items

As an integral part of the make-or-buy effort, sufficient data will be released to permit intelligent make/buy decisions and intelligent quotations for buy items. Because of the short duration of Phase C and the number of modules (i.e. components) to be designed, preliminary module specifications will in general consist of the requirements applicable to all items, plus a summary sheet of the requirements of the item involved.

2.5.2.9 Required Drawings

GE-Space Systems Organization has in place a drafting system which meets the requirements of MIL-D-1000 Form 2 drawings. During Phase C, all drawings called for in consonance with the GE Stage I Stage Release requirements will be released meeting these standards and satisfying the content requirements of Category A "Design Evaluation", Category B "Interface Control", or Category F "Procurement" (interchangeable items).

2.5.2.10 Preliminary Test Specifications

Preliminary test specifications will be developed during Phase C for each equipment identified as a CEI or Engineering Critical Component, as based on the Preliminary Test Requirements. They will be incorporated directly or by reference in the applicable CEI and component specifications.

2.6 TEST PROGRAM PLANS

The presently defined Phase C program may have a small amount of exploratory testing (not presently planned). However, the principal test program effort in Phase C will be the development of an Integrated Test Plan for use in Phase D. The objective will be to plan a test program which provides maximum flight confidence at minimum cost.

Key features of the test plan:

- Test planning is established as a program-wide effort, led and integrated by experienced test planning personnel.
- Test planning is programmed during Phase C to proceed with the preliminary design process.
- The resulting test plan will cover:
  - All categories of testing (development, qualification, verification, acceptance)
  - All levels of testing (component through system)
  - Objectives, relationships, environmental levels, reporting requirements of all tests
  - Description of required test facilities

The test planning steps will be

- Initial Scoping/Preliminary Development Test Outline
- Update Development Plan/Scope Qualification Plan
- Initial Test Plan Drafted
- Update Documents/Planning Analyses

An Integrated Test Plan will be evolved which will include the following:

a. Test "Matrix" (Tests matched to requirements to be verified)

b. Development Tests

c. Qualification Tests

d. Validation Tests

e. Acceptance Tests

Further details regarding this plan contained in "Plan for Integrated Test Plan", Section 7 of this volume.

2.7 MANUFACTURING PLANS

2.7.1 PHASE C ACTIVITIES

During Phase C, manufacturing activities will include:

- Support and influence the design from a producibility standpoint.
- Participate in vendor surveys; contribute to the make/buy process and prepare for Phase C purchases.
- Perform preliminary manufacturing planning and contribute to facilities planning.

2.7.2 MAKE OR BUY PLAN

During Phase C, make or buy decisions will be accomplished in accordance with the Make or Buy Plan and Space System Organization policy. Make/Buy decisions will be made by a Make/Buy Board and source selection decisions by a Source Selection Board, both having representation from affected sections and both chaired by the Program Manager. The make or buy process includes determination of proper work packages for Make or Buy consideration, vendor and industry surveys and the make or buy decision using the best source irrespective (without abrogating General Electric's responsibility for System performance) based on the following criteria:

a. Customer Requirements

b. General Electric Capability and Capacity

c. Industry (Vendor and/or Subcontractor) Capability and Capacity

d. Relative Cost and Schedules

e. Design status and Interface Definitions Status

f. Product Quality

g. Small Business Participation and Labor Surplus Areas

The Source Selection process includes RFP's to qualified bidders, evaluation of technical, management and cost aspects of proposals by appropriate disciplines, recommendation to and source selection by the Source Selection Board, and fact-finding and negotiation. The results of Phase C make or buy and Source Selection activity will become part of the Phase D Make-or-Buy Plan.

2.7.3 MANUFACTURING PLAN

During Phase C, manufacturing will perform and document in a Phase D Manufacturing Plan the planning to define the operating methods to be used in Phase D for procurement, fabrication and assembly of hardware to meet the quality and reliability requirements while fulfilling the schedule needs. It will also define the organizational structure, their functions and responsibilities, tasks and subtasks. The plan will include an integrated hardware flow, schedule sequence of manufacturing operations (including process specifications to be used), methods, tooling to be utilized, proposed factilities, special tooling, equipment handling procedures, and manpower needs.

2.7.4 FACILITIES PLAN

General Electric has undertaken an analysis of the facilities required to support Phases C and D of the IMBLMS Program. Most of the required facilities are currently in existance at the Missile and Space Division; however, some equipment necessary to support IMBLMS unique requirements will be acquired.

The IMBLMS Program has General Electric management's assurance that a separate IMBLMS laboratory will be set up and equipped. Of particular importance to IMBLMS will be the availability of the neutral buoyancy tank for simulation of IMBLMS transport and operations. This tank will be completed at the GE Valley Forge Space Complex during the summer of 1968.

The Phase D facilities plan prepared in Phase C will contain an integrated description of all General Electric and possible Government owned facilities to be used in Phase D for the development and production of software and hardware for IMBLMS. Facilities will include all laboratories and inspection and test facilities, production facilities, and support facilities required for the IMBLMS program. The plan will describe how the facilities will be used and predicted loadings.

2.8 RELIABILITY AND QUALITY ASSURANCE PLANS

2.8.1 RELIABILITY PLAN

The reliability requirements of NPC 250-1 will be implemented during Phase C of the IMBLMS program by a reliability team consisting of members of the Departments' IMBLMS Engineering, Design Reliability Engineering and QA&R Reliability and Safety Engineering.

The Reliability Plan for Phase C includes establishment of reliability goals and apportionment, prediction of reliability versus goals, Failure Mode, Effects and Criticality Analysis and completion of design trade studies.

Further definition of the Reliability Plan for Phase C is documented in Section 8 of this volume.

2.8.2 QUALITY ASSURANCE PLAN

The Product Assurance Section of the Space Systems Organization will follow a quality program in accordance with NAC 200-2 during Phase C of the IMBLMS program.

The IMBLMS equipment design will be documented during Phase C by Stage I Engineering Documentation and Part I CEI Specifications. This design will be reviewed by Quality Control Engineering to assure that all aspects of quality, such as producibility and testability, are designed into the equipment.

Materials and Processes Engineering will develop lists of selected materials and processes that are acdeptable for AAP equipments and review the IMBLMS design to assure proper selection and application of all materials and processes.

Contributions to test programs for development and qualification testing will be made by QA&R. The total plans will also be reviewed by QA&R.

Quality Assurance and Reliability Provisions documents will be prepared for all IMBLMS equipment determined to be critical buy items.

Further definition of the quality program planned for Phase C is documented in Section 9 of this volume.

2.9 SYSTEM SAFETY ENGINEERING PLAN

2.9.1 INTRODUCTION

The preliminary system safety engineering plan is herein defined. This outline presents the proposed organization and activities which will comprise the plan. The approach defined is in accordance with MIL-S-38130A.

2.9.2 SYSTEM SAFETY ENGINEERING RESPONSIBILITIES

A System Safety Engineer reporting on assignment from the Reliability and Design Safety Operation to the Program Manager will exercise primary cognizance over program safety activities and will be responsible for the conduct, administration and control of the safety program. The authority and responsibility of the engineer to monitor the functional groups to insure compliance with safety regulations will be defined. In situations where controversy arises and cannot be resolved on a direct operating basis, a direct channel of the IMBLMS Program Manager will be used.

The Safety Engineer will be the coordinating agent for all safety matters affecting the program at GE, subcontractor facilities, other interfacing organizations, and with NASA.

2.9.3 SYSTEM SAFETY REQUIREMENTS

The board-spectrum safety program to be conducted on the IMBLMS Program will incorporate protective measures as follows:

a. For astronauts and all other persons working with the equipment - from spacecraft equipment design and hazardous operating procedures

b. For spacecraft hardware and equipment - from itself or interfacing equipment in the event of failure

c. For spacecraft hardware and equipment - from people.

2.9.4 MODULE ANALYSIS AND POST-ANALYSIS ACTION

Hazards and their degree of criticality are identified for each IMBLMS module by considering the module itself, the interfacing of modules, and the interaction with the astronauts, spacecraft, support equipment and facilities. The design engineer shall be responsible for the hazards identification and classification coordinated by the systems safety engineer. Preliminary system safety hazards will be identified in the Phase C design process.

As a result of the analysis the following action will be taken in descending order of preference to minimize hazards:

a. Design for minimum hazard - To obtain a high degree of inherent safety through the selection of appropriate design features, proven components and operating principles

b. Employment of safety devices - Where hazards cannot be eliminated, reduction of risks by incorporation of safety devices.

c. Incorporating warning devices - Where hazards still exist, use of warning devices

d. Devising special procedures - Where the nature of the hazard is such that use of the above fails to reduce the risk adequately, use of special operating procedures minimize the possibility of a hazardous event.

2.9.5 HAZARD CLASSIFICATION

Utilizing failure modes and effects analysis a classification will be made of all identified hazards. They will be classified as follows:

I. Safe - No system or personnal damage

II. Marginal - Degrades without major damage

III. Critical - Substantial system/personnel damage

IV. Catastrophic - Loss of mission or loss of life.

NASA will be advised of design and procedures aspects which have been classified as critical or catastrophic, and specific corrective action will be defined. Class IV, catastrophic Items, and Class III, Critical Hazards, will be eliminated or minimized consistent with program objectives.

2.9.6 SYSTEM SAFETY ANALYSIS AND POST-ANALYSIS ACTION

The first goal of the safety engineer is to ensure that safety is designed into the spacecraft and associated equipment. Design criteria based on identification of safety hazards will be utilized to accomplish this. Tradeoffs will be made in hardware design which will result in an acceptable balance between reliable performance and a sometimes unavoidable degree of safety risk. Through the use of a number of accepted and proven analytical techniques, the subsystems will be analyzed to determine the effect of failure or premature operation on the safety of the system. The System Safety Engineer will participate in all Design Reviews and review and approve all specifications and design releases.

As deficiencies or potential hazards become apparent through analysis, discussions will be held with the appropriate design engineer to effect the necessary changes. Where safety features would involve or affect other equipment and/or operations, the problem will be resolved by a board consisting of a representative of each major function involved, and chaired by the Systems Safety Engineer. Recommendations of the board will take into account the operational requirements and the tradeoffs of weight, size, cost and schedule. Resultant changes in design to reduce or eliminate the hazard will be fully coordinated with the design engineers who will be responsible for having these changes made to the appropriate drawing and specification.

2.10 LOGISTICS SUPPORT PLANS

Logistics support plans to be developed during Phase C for implementation in Phase D will be based on the hardware design developed during Phase C, the results of maintainability analysis, and the spare parts provisioning requirements. Support equipment development and training plans will also be generated. These plans will include the organization structure, responsibilities, and relationships for establishing provisioning, site, and on-board inventory, and transportation and storage and constraints.

2.10.1 MAINTAINABILITY PROGRAM

During Phase C, General Electric will implement a maintainability program consisting of three key efforts:

a. The generation of a formal maintenance concept defining the accomplishment of preventive and corrective maintenance during the ground flow cycle from fabrication through launch and during orbit, so that the hardware design will evolve in support of the maintenance concept. Maintenance policies will be integrated with AAP operational and support concepts and requirements. Policies relating to launch site maintenance provisions, manual versus automated checkout and fault isolation techniques, and the allocation of orbital time to maintenance operations will require special attention.

b. The development of design requirements for maintaining the system elements at an acceptable level of overall effectiveness by the evaluation of the gross system maintenance concept in relation to hardware specification requirements. Particular emphasis will be placed on:

   1. Accessibility
   2. Ease of replacement
   3. Interchangeability
   4. Operational status verification

c. The development of a Maintainability Plan for use during Phase D. The plan will contain a description of the tasks and activities to be performed and the methods to be used to achieve optimum on-orbit and prelaunch maintainability and the management organization responsible for control and implementation.

The maintainability program will aim at avoiding costly maintenance during prelaunch operations and/or costly redesign in the program. Effective data return from the IMBLMS can only be assured if provisions are made early for flight crew response to on-board contingencies through a maintainability program.

2.10.2 SUPPORT EQUIPMENT DEVELOPMENT PLAN

This plan will consist of three sections, the first concerning Operating Ground Equipment, the second concerning Maintenance Ground Equipment, and the third concerning onboard maintenance equipment. The plan will establish responsibilities and time phasing for detailed analysis of needs and for start and completion of design and development, as related to the flight equipments. The plan will be used as a base for conducting systematic review and analysis of needs for support equipment. It will also serve as a source of information affecting system or end-item design in that an analysis of functions requiring support, coupled with maximum utilization of existing flight items and optimum maintainability, will result in tradeoffs between end items and support equipment design.

2.10.3 TRAINING PLAN

During Phase C of the IMBLMS Program, a training plan will be prepared. This will require performance of a Personnel Training Requirements Analysis (PTRA) to identify the type and scope of training to be recommended for operation and maintenance. Additionally, this training plan will require identification and depth of coverage required for course charts, lesson plans, manuals, and visual aids, to support an adequate curriculum. This plan will cover both ground and flight personnel training. A significant feature of the Phase D effort will be the development of an experiment timeline analysis and a development test program using functional engineering prototype hardware. This exercise will afford the opportunity to realistically appraise the Phase C training plan for revision in Phase D.

2.11 PHASING AND SCHEDULES

2.11.1 MASTER PHASING SCHEDULE

The phasing of the Phase C IMBLMS Program is shown in Figures 2-6 and 2-7, Major Milestone Schedule - Part I, Management and Part II Technical. These are based on weeks after go-ahead and assumption of a March 4 commencement.

This scheduled go-ahead is March 4 followed in 2 weeks by an updating of NASA inputs of Revised Measurement Requirements. The contractor's identification of measurements that constitute the basis for design will then be established by six weeks after go-ahead. This is predicated on the NASA inputs not causing a major change in measurement requirements.

Monthly Progress Reports will be submitted to NASA throughout the Design Phase. An oral mid-term review which in effect is a Conceptual Design Review is scheduled twelve weeks after go-ahead.

The contractor's Phase D program recommendations will be submitted sixteen weeks after go-ahead. The receipt of the RFP for Phase D is anticipated twenty-one weeks after go-ahead, which will be followed by delivery of the contractor's Summary Report and Phase D proposal twenty-five weeks after go-ahead. This will constitute the end of Part I of Phase C.

The succeeding 2 months of effort will be directed toward updating and revising the Summary Report culminating in submittal of the Final Summary Report the end of thirty-one weeks after go-ahead.

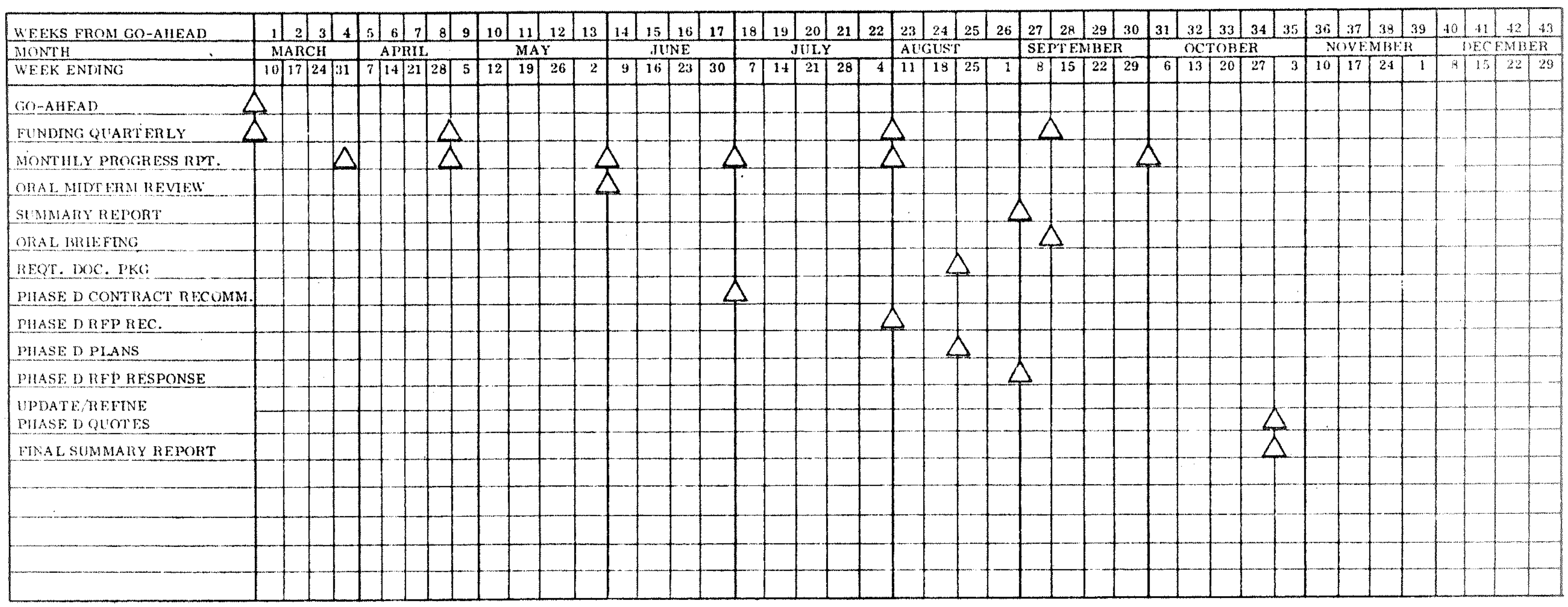


Figure 2-6. IMBLMS/Phase C - Major Milestone Schedule Part I - Management

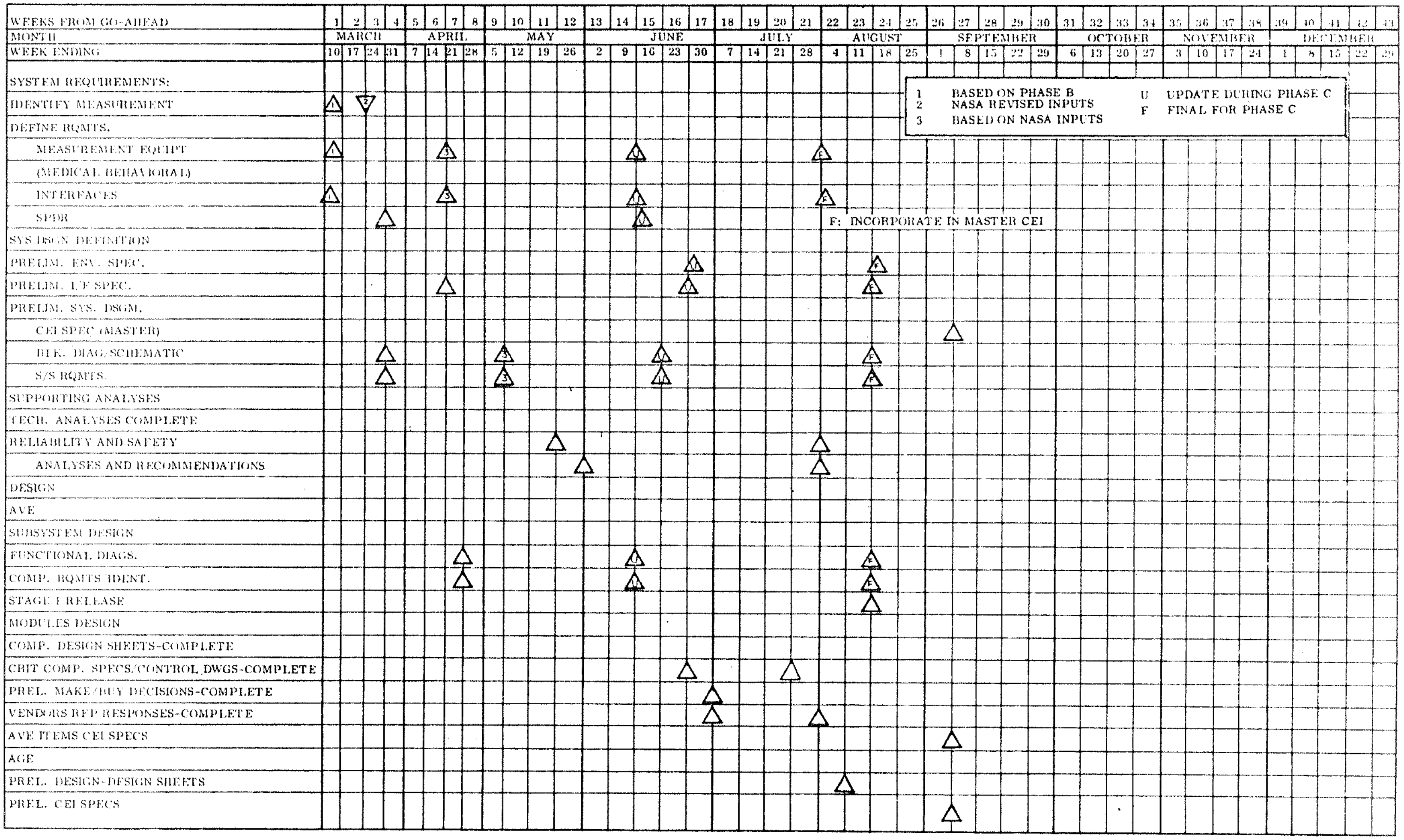


Figure 2-7. IMBLMS/Phase C - Major Milestone Schedule Part II - Technical

2.11.2 SCHEDULES BY TASK

The detailed Milestone Schedules for the tasks to the Level 2 and Level 3, as applicable, are provided in the Management Control Plan.

2.12 MANPOWER PHASING AND REQUIREMENTS

2.12.1 MANPOWER PHASING

The manpower requirements for the IMBLMS Phase C program have been developed based upon the task definitions of the Work Breakdown Structure. These direct labor manpower requirements have been consolidated and are shown time-phased in the Manpower Profile, Figure 2-8. As can be seen from this plot the requirement peaks in February 1968, at 40 equivalent applied people. Effort phases down to nominally 15 people for revision-updating work of Part II.

The work by other General Electric people outside the Research and Engineering Operation, which appears as a material item, when converted to people, would add 10 equivalent people at the peak and an additional 3 people at either extreme of the profile.

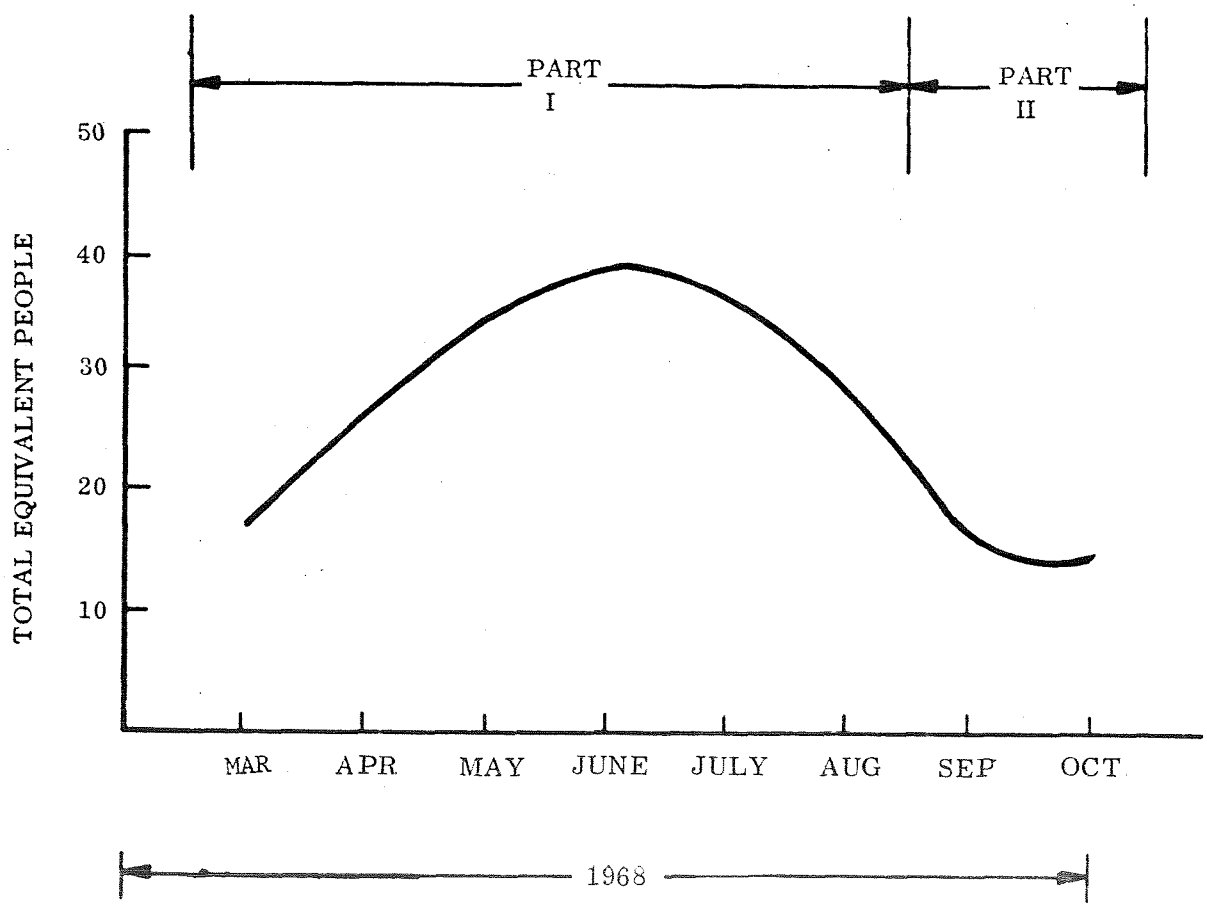


Figure 2-8. IMBLMS Phase C Manpower Profile

2.12.2 MANPOWER BREAKDOWNS

A breakdown of the manpower requirements in terms of both man-hours and equivalent average numbers of people are shown both by task and by organization. Table 2-1 Manpower by Tasks, shows the requirements by Level 1 and Level 2 tasks. The average number of people on the program totals 28.6 of which approximately one-third are the System Engineering task and another one-third the Design Engineering task.

Table 2-2, Manpower by Organizations, breaks out the requirement by organizational sections or units within the Research and Engineering Operation. The largest single portion of the effort, over one-third, is drawn from the IMBLMS Engineering Operation.

The work by other General Electric people would add 6.1 average number of people to the total of 28.6 and these would be principally of the Design Engineering type who will perform under Task 3000.

2.12.3 MANPOWER CONTROLS

The direct labor manpower that is allocated to each task will be in accordance with the Program Funding Instruction (PFI) which is issued by the Program Manager. This control thus exercised is of a fiscal nature and is described in Section 3.3 of this volume.

An immediate and specific manpower-oriented report used by the Program Manager is the "Weekly Shop Order Charges Report". This report which is issued promptly after the close of the week, identifies charges to the program by individual name/badge number and shop order number. Monitoring of this by the Program Office can reveal anomalies, prompt investigation and foster immediate adjustments to manpower assignments. Control of "indirect" manpower is discussed in the Management Plan.

Table 2-1. Manpower Breakdown By Tasks

Task	Name	Hours	Avg. People
1000	Prog. Management	8,230	6.0
1100	Proj. Engr. Mgt.	5,080	3.7
1200	Proj. Control	2,200	1.6
1300	Contracts & New Tech.	950	0.7
2000	System Engr.	11,250	8.2
2100	Syst. Rqmts.	3,828	2.8
2200	Syst. Analyses	5,172	3.8
2300	Syst. Dsgn & Integ.	2,250	1.6
3000	Design	20,325	14.0
3100	Flight Equipment	18,765	13.0
3200	Ground Support Equipment	1,560	1.1
4000	Phase C Support & Phase D Plng.	6,665	5.4
4100	Mfg.	954	0.7
4200	QA & R	2,720	2.0
4300	ST & D	670	0.5
4400	Dsgn. Rel & Safety	2,990	2.1
	Total	47,149	34.7

Table 2-2. Manpower Breakdown By Organizations

Organization		Hours	Avg. People
7H10	Contr. Adm.	950	0.8
7H20	Technical Publications	2,106	1.5
7K30	Finance	134	0.1
72A0	Design Reliability and Safety	2,990	2.1
72C0	Drafting	3,400	2.5
7300	QA&R	2,720	2.0
7410	Medical	1,850	1.3*
7430	Human Engineering	3,595	2.6
7440	IMBLMS Engineering	14,458	10.6
7450	Program Office	5,040	3.7
7580	ST & D	670	0.5
7660	Manufacturing	954	0.7
ASD		8,272	6.1
		47,149	34.7

*Dr. R. W. Lawton, Manager Bioastronautics, will actively participate in the program, yet is independently funded. In addition, Medical Consultants (such as Dr. T. G. G. Wilson, Temple University Medical School) will be utilized as required.

SECTION 3

MANAGEMENT PLAN

3.1 INTRODUCTION

The General Electric Company has established the Space Systems Organization within the Missile and Space Division, incorporating the most significant manned orbital spacecraft capability that could be assembled within the Company. Because of the importance of the IMBLMS to the Spacecraft Systems Programs the IMBLMS team for Phase C has been est established within the Space Systems Organization. Included as team members are those employed in the Phase B study.

Figure 2-1, in Section 2 Program Plan, shows the corporate position of the Space Systems Organization reporting vertically to the President of the General Electric Company. Figure 2-2 shows the organizational and functional responsibilities of each group within the Space Systems Organization. Figure 2-3 shows the organization of the IMBLMS Program as the authority flows from Dr. Lawton.

3.2 PROGRAM MANAGEMENT

3.2.1 PROGRAM MANAGEMENT ORGANIZATION

The organization for Program Management of Phase C IMBLMS departs from the conventional line-staff organization normally used in the management of large or complex programs. It is a management concept which utilizes all of the strengths of the functional segments of the organization while pin-pointing specific responsibility for accomplishing a task. Under the Program Manager concept, responsibility is assigned to a single person, and it is he who establishes the objectives, develops the plans, determines the commitments, and evaluates the progress against schedule, cost, and technical performance.

A General Manager is responsible for integration of the functional contributions of his organization where only one or two relatively stable programs are carried on at one time, the work of integration could be performed by the General Manager. However, where there are a number of complex and dynamic programs, the General Manager delegates his authority to his Program Managers.

The Program Manager is completely program oriented. The instructions from his program organization flow directly to the functional organizational level taking action. He is the focal point of communication between the Department and the customer's organization. While acting as the Department General Manager's delegate in managing the Program, the Program Manager is looked to by the customer for assurance of a quality product on time and within cost.

(This is to be an added section to be inserted in customer relationships.) A major function of the Program Office is external relationships primarily with the customer and additionally, as the customer directs, with concerned contractors, experiment personnel, etc. Therefore, a major assigned duty of the Program Office must be to carry these out. For purpose of convenience, we might classify external contacts into four groupings.

First is the program relationship. This relationship is conducted personally by the Program Manager dealing with his NASA counterpart. The Program Manager in GE is assigned this duty as a major part of his effort in order to assure that the program is conducted in accordance not only with good business practices and good internal techniques but also in accordance with achieving, for mutual benefit, the program which the customer desires and which is in accordance with the contract.

The second grouping comprises exchanges of technical information. It has always been a policy that exchange of technical information between interested counterparts is to be encouraged rather than discouraged since only this can provide the depth of technical understanding so necessary for mutual benefit. However, in all cases, technical personnel are required to obtain program permission, and are advised that formal committments can be made only through the Program Manager and that records are to be kept of technical contacts which may have program implications.

Next, there is the formal chain for controlling and amending the contract scope. For this purpose a Contract Administrator deals with his NASA counterpart. However, in order to provide a single point direction and control capability within the GE company, the Contract Administrator's outputs internally to GE are to the Program Manager and not directly to the operating groups; in this way there is no confusion as to the chain of program direction and control.

Finally there is the vital external relationship in terms of technical interfaces; that is the agreements and documents, the planning of these, the carrying of action items, etc. which are necessary in order to "pin down" technical interfaces between the various organizations contributing to a program. This is discussed further below.

3.2.2 SOURCE RESPONSIBILITY AND AUTHORITY OF THE PROGRAM MANAGER

Section 2, Figure 2-2 shows the Space Systems Organization chart. Authorized members of the Business Management Section, acting for the General Manager, are authorized to commit the Organization by signing contracts. The same Figure 2-2 shows the flow of responsibility and of authority from the General Manager through the Research and Engineering Operation and Bioastronautics Section to the IMBLMS Program Manager for conducting Phase C of the IMBLMS Program.

3.2.3 MEANS OF DELEGATING RESPONSIBILITY AND AUTHORITY FROM THE PROGRAM MANAGER

Section 2, Figure 2-3 shows the organizational relationship among the members of IMBLMS Program Management. Below this level, responsibility flows by standard means, i.e., functional charters, position descriptions and other formal methods of delegating responsibility. Delegation of responsibility and authority from the Program Manager to various working levels in the functional organizations for program contributions is accomplished by use of the Program Funding Instruction (PFI), as described in paragraph 3.3.3.3

3.3 INTERNAL MANAGEMENT

3.3.1 UTILIZING MANAGEMENT CONTROL PLANS FOR PROGRAM AND TASK PROGRESS CONTROL

Program Management Control of program and task progress is delineated by Program Management Work Package Tasks at Level 2 of the Work Breakdown Structure (Section 4, Management Control Plans.) Certain sections of the Management Plans may be identified as used in accomplishing this control by the Program Manager and his staff:

WBS Level 2	Work Package Task	Management Plans (Paragraph Reference)
Project Engineering	Interface Plan	2.3.2
Project Engineering	Configuration Plan	3.3.2
Project Engineering	Documentation Plan	5.0
Program Control	Schedule Control	3.3.1.1
Program Control	Cost Control	3.3.3
Program Control	Subcontract Management	3.4
Contract and New Technologies Administration		3.3.1.2

3.3.1.1 Schedule Control

The lowest organizational level for which scheduling and control is implemented is the recipient of a Program Funding Instruction (PFI) as described in paragraph 3.3.3.3. Control of these schedules is integrated and consolidated into a key milestone schedule as part of the Phase C Program. The Integrated Milestone Reporting System (IMRS) will be used to control the schedules which have been committed to NASA.

3.3.1.2 Contracts and New Technologies Administration

Requirements of the New Technology clause, NASA Form 1162, will be complied with. The provisions of this form are as follows:

a. Prompt reporting

b. Frequent periodic reviews

c. Written summaries of review activities

d. Include New Technology clause in subcontracts

e. Annual reporting on subcontracts over $50,000

f. Obtain subcontract certification of compliance

g. Notification of first public use, sale, or publication of inventions.

A New Technologies Representative (NTR) will be appointed for the IMBLMS Program, specifically to implement compliance with the above requirements.

3.3.2 DESIGN CONTROL

3.3.2.1 Design Release

During the Phase C Program, control of the design of equipment will be maintained in accordance with existing Design Engineering Section Instructions describing the Engineering Stage Release System. In essence, this system is a time-phase systematic method of planning and documenting the availability and identification of the documents which contain the technical information associated with the development of the engineering design. It is used for the following purposes:

a. To identify the engineering information required in the development of a program, subsystem, component, or end item design and to provide a check list of this information.

b. To provide a method of publicizing the availability of technical information generated as part of the design/development.

c. To assure that all interfacing areas are informed of the progress of the design activity.

d. To identify the operations responsible for the preparation of the required information.

e. To assure completion of all Stage requirements.

There are two types of Stage Releases in the system: namely, 1) Engineering Development/Subsystem Release and 2) Component Release (applied to IMBLMS modules).

Phase C will take the design through Subsystem Stage I Release and generally through Stage I Component (module) release which includes maximum requirements and dimensions definition. The Engineering Development/Subsystem Stage Releases preceding the Component Stage I Release are as follows:

Stage 0 Examination of Work to be Done

Stage 1 Finalization of System Requirements

Figure 3-1 shows the flow of information accompanying and Engineering Development/ Subsystem Stage Release through Stage I. Figure 3-2 shows the same information for a Component Stage Release through Stage I.

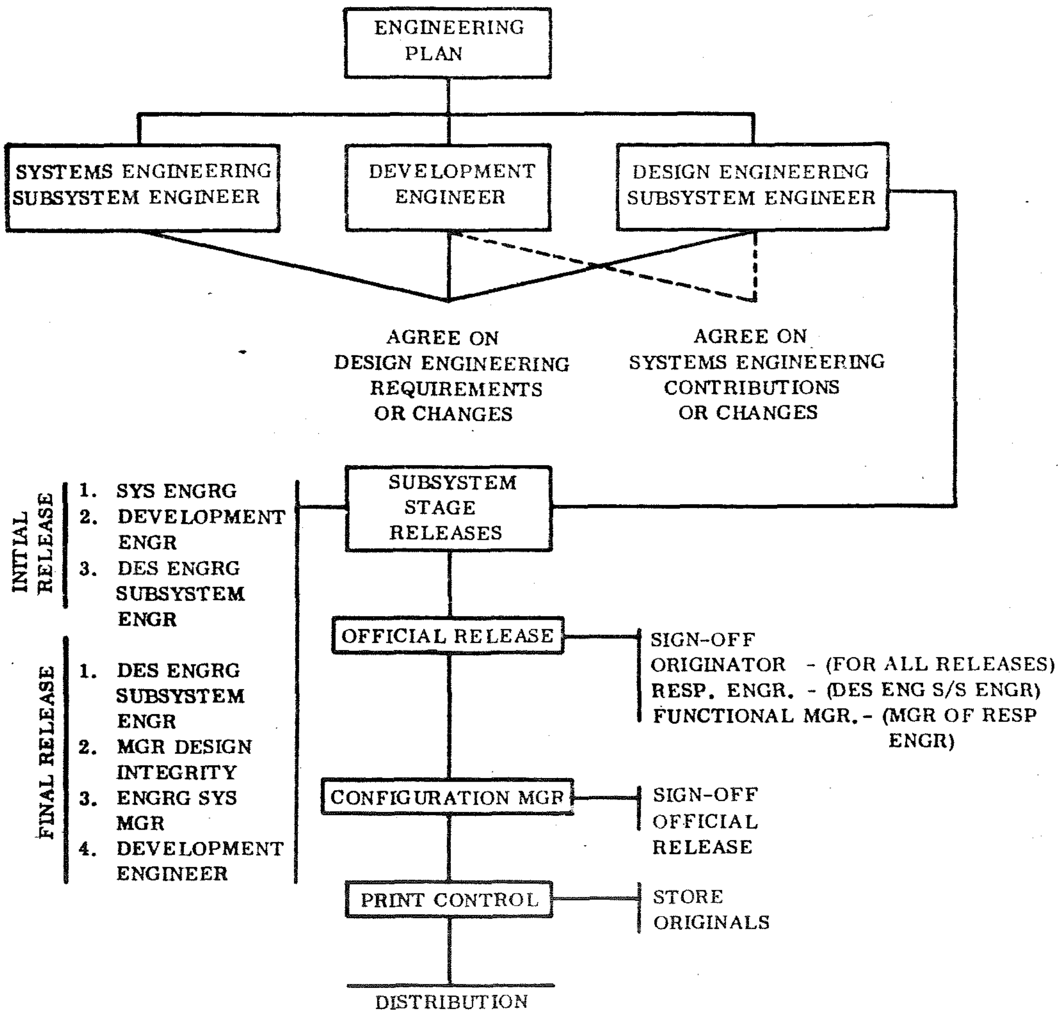


Figure 3-1. Typical Subsystem Stage Release Flow Chart

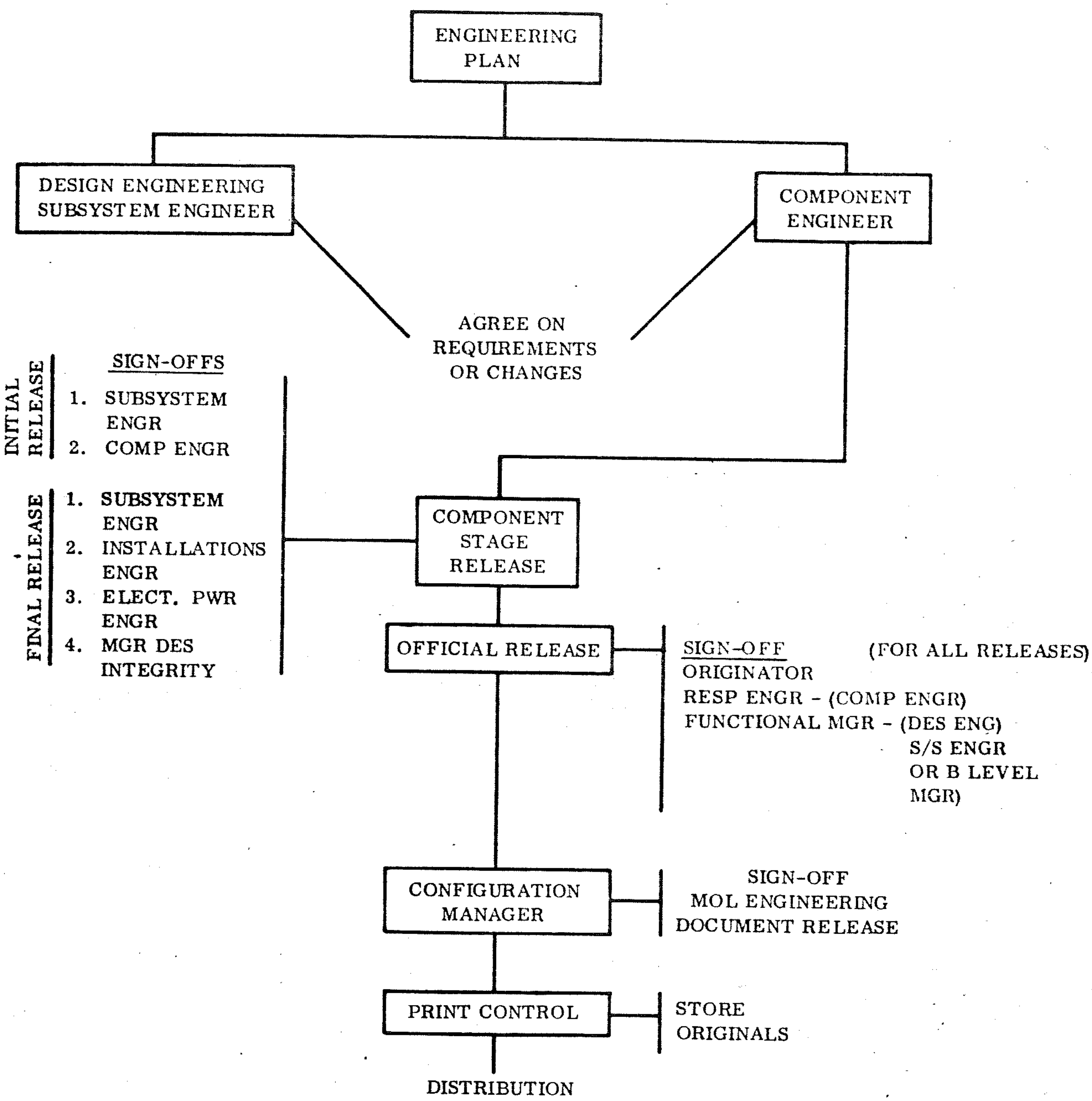


Figure 3-2. Typical Component Stage Release Flow Chart

3.3.2.2 Design Change

Formal customer-oriented configuration control does not become operative until Stage IV Component Release has been made. At this point, design change will fall under the formal controls to be prescribed in the Configuration Management Plan.

However, an integral design change control commensurate with the Preliminary Design stage of the program will be used: A planned cycle of early initial release update followed the mid-term concept review, and "final Phase C" configuration release is subjected to a change control on the technical design providing all concerned to work with a controlled baseline design.

The Configuration Management Plan will describe and outline the methods and procedures used in assuring proper configuration release, identification, control, and accounting during Phase D.

It will contain sufficient information concerning the following elements, to reflect GE Space Systems Organization competency to meet the objectives of Configuration Management as specified in NPC 500-1, Apollo Configuration Management Manual:

a. Organizational structure and relationships (Administrative and Functional)

b. Responsibility assignments

c. Methods and responsibilities for baseline establishment, identification, and control, including the role that specifications play in this area

d. Methods and procedures to be used in, and responsibilities for, control of changes in design

e. Methods and procedures to be used and responsibilities for configuration accounting and configuration identification.

3.3.3 FINANCIAL MANAGEMENT

Meaningful and realistic budgets on a functional organization basis are established for both direct and indirect costs. Measurement against those budgets and reporting of variances to the appropriate level of management on a timely basis provide emphasis in those areas requiring corrective action.

3.3.3.1 Financial Budget

3.3.3.1.1 Direct Costs

Direct manpower and direct material costs are budgeted through the Program Funding Instruction (PFI) routine described in paragraph 3.3.3.3, Cost. Requirements are estimated by each organization for performing assigned work based upon the appropriate level of the Work Breakdown Structure. After evaluation of these requirements by the Program Manager, PFI's are negotiated with the responsible organization to establish the budget for the work. The total of these PFI's form the overall Program cost budget.

3.3.3.1.2 Indirect Costs (Overhead and General and Administrative Expenses)

Budgets for indirect costs are established on a calendar year basis. Each Section within the Department submits its estimate of indirect manpower and indirect costs for the calendar year to the Finance Section. These estimates reflect the anticipated support effort and indirect expenses required to accomplish the direct contract effort.

On the basis of these inputs, the Finance Section compiles a budget for Engineering Overhead Expense, and for General and Administrative Expense. Evaluation is made by the Finance Section of the individual Section estimates and the overall Department estimate to assure compatibility of these estimates with the contract work load support requirements of the Department. Revisions recommended by the Finance Section on the basis of this evaluation are coordinated with the Section Managers to obtain their concurrence or recommendation for referral to the General Manager. Upon completion of the General Manager's review and incorporation of his recommendations, indirect cost budgets by Section are prepared for final approval by him. These approved Section budgets become the baseline against which each Section is measured. The consolidated Department budget forms the basis for the forward pricing and provisional billing rates proposed to the Air Force Plant Representative Office (AFPRO).

3.3.3.2 <u>Financial Control</u>

Control of direct and indirect costs is accomplished through a systematic routine of reporting, measurement, and implementation of corrective action. Internal reports, some weekly and some monthly, reflect both current expenditures and year-to-date expenditures against the established budgets.

Indirect expense and manpower data are accumulated from the same sources as the direct costs and manpower; i.e., labor data comes from the Payroll System, and material and service data comes from the Accounts Payable System. The indirect budget functions the same as that of a direct cost shop order, except that the codes identify indirect expense classifications instead of subdivisions of the Work Breakdown Structure. Overhead and G&A Reports are issued monthly. These reports are at various levels of detail for close management control.

3.3.3.3 <u>Program Funding Instruction (PFI) Routine</u>

Cost on Phase C will be controlled by the PFI/Financial Report method currently in use. PFI's will be used to budget the labor hours and material allocation by work package by month for the planned duration of the work package. Work packages are identified efforts having measurable starting and ending points, and are normally selected to cover periods such that two packages for Part I of the Phase C Program and a separate package for Part II of the Phase C Program would be expected. This assures financial control by identified package of effort. Each PFI will have its own work statement and milestone schedule and will be negotiated by the Program Manager with the responsible operation and issued over his signature. Agreement will be reached, before starting work, on task to be accomplished, on the schedule, and on the estimated cost. Thereafter, the PFI scope and/or funding can be changed only by agreement between the performing operation and the Program Manager. Each week, following cost accrual for the preceding week, a computerized report will be issued to show the charges against each PFI and work package. The work progress against the previously agreed-to milestone schedule will then be measured by the responsible operation and by the Program Manager.

Each PFI is, in effect, a contractual commitment by the performing organization to the Program Manager. The performing organization, with the assistance of the Program Manager, establishes a detailed schedule with measurable milestones, a budget (by task and for total work package), and detailed technical task definitions. The monitoring of work performance then becomes a matter of tracking completion of milestones (or estimating progress toward completion), of weekly cost accrual reports to measure expenditures against budgeted commitment, and review and judgement to ascertain the adequacy of technical performance. By initially assigning a budget to each task and then tracking expenditures for each task, the value of work performed is tracked and areas of potential or actual overrun are readily identified for corrective action. Each performing organization reports progress to Program Manager at least weekly, more frequently when problems arise.

3.3.4 MANPOWER (STAFFING)

3.3.4.1 Policy

The General Electric Space Systems Organization is staffed to provide the number and types of people with the proper education, talents, and skills to accomplish the direct effort under the IMBLMS Phase C Program. It is also staffed with the types and number of indirect charge people required to support direct labor and to provide the necessary administrative effort.

In addition to its own staff, the Department may draw upon the manpower resources of other Departments of the Missile and Space Division as well as other departments and laboratories throughout the General Electric Company as required to fulfill its contract obligations.

3.3.4.2 Manpower Control

Each Manager within the Organization is charged with the responsibility of maintaining his staff of direct charge employees at the level that does not exceed that for which he is funded through the Program Funding Instruction (PFI) routine described in 3.3.3.3, thus providing two controls on direct manpower: first, by the Program Manager who controls the direct manpower for the Program by the PFI routine; and second, by the Section and lower level Manager who controls direct manpower in his organization by the sum total of all PFI's issued to him. The Program Manager receives weekly cost reporting tabulations which indicate the names of the people charging to the program and the amounts charged. This funding information compared against progress is indicative of the financial health of the program. In addition, the managers of each of the work packages receive weekly cost reporting tabulations which indicate charges against the work package. With this information he can show the program manager the status of his work from the standpoint of planned progress vs money expended to date. Planning of indirect manpower and expenses is done on an organization basis (see 3.3.3.1.2).

3.4 SUBCONTRACT MANAGEMENT

3.4.1 PHASE C ACTIVITIES

During Phase C, subcontractor activities involve the effort from vendor surveys and make/buy decisions through bids, and at the most subcontractor negotiation (Reference Make/Buy plan). For this effort, a full time Subcontracts Manager has been appointed. The Subcontracts Management tasks described below are largely Phase D tasks in the conduct of subcontracts; however, the effort in Phase C of preparing for Phase D contracts is directly based upon how anticipated subcontracts will be managed.

3.4.2 ADMINISTRATION

A key element of procurement is the management and control of major subcontracts. General Electric is implementing the subcontractor "Project Manager" concept to ensure successful subcontract performance and control. The Subcontract Project Manager who reports to the Program Manager is responsible for all management and direction of subcontracts from make/buy decision through delivery, thus providing single-point authority. Supporting this approach, management control through Subcontract Program Operations and contractual control through Subcontract Business Management of the Space Systems Organization provides the required management uniformity and visibility over all major subcontracts.

The Subcontract Project Manager is the single point of contact for all subcontract administrative activities, as appropriate to the specific rpocurement. The Subcontract Business Management Office of the Space Systems Organization is responsible for all contractual communications with the subcontractor maintaining current status of all contractual documents, open items, and the performance of all contractual negotiation and change actions.

Open items of a contractual nature are recorded, and an "Action Item List" is maintained and published weekly for administrative disposition. Subcontract closeouts and terminations are processed in accordance with General Electric procedures, consistent with Government regulations.

Each change to a subcontract is negotiated on its own merit whether the change is initiated by the subcontractor or GE-Space Systems Organization. The proposal, review, negotiation and approval cycle used for the original subcontract is followd prior to amending a subcontract.

3.4.3 TECHNICAL DIRECTION

A major function of the Program Office is plan and control external relationships, primarily with the customer, and with others as the customer directs.

This effort is spearheaded by the Program Manager, Mr. A. A. Little who will maintain a close relationship with Mr. N. Belasco, his NASA counterpart. The remaining team "running mates" will be designated by name when known and will function in support of the direction of the Program Manager. This is treated in further detail in section 3.2.1.

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